PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

EDITED BY

CHARLES VINCENT WALKER, Esq., F.R.S.,

TILL 1864, JUNE;

AND BY

JAMES GLAISHER, Esq., F.R.S.,

FROM 1864, NOVEMBER.

VOL. II.

1863, NOVEMBER 18, TO 1865, JUNE 21.

LONDON:

TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

September 1865.

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BRITISH METEOROLOGICAL SOCIETY.

VOL. II.] 1863, NOVEMBER 18. [No. 9.

R. DUNDAS THOMSON, Esq., M.D., F.R.S. L. & E., President, in the Chair.

Lieut.-Col. Henry Austen, Rockville Tenby, S. Wales;
Henry Deane, Esq., Clapham, Surrey, S.;
Henry Deane, jun., Esq., Galway, Ireland;
Daniel Doncaster, jun., Esq., Doncaster Street, Sheffield;
William C. B. Eatwell, Esq., M.D., Bengal Army, Oriental Club;
Chas. D. Turton, Esq., Lagos, W. Coast of Africa;
were balloted for and duly elected Members of the Society.

The names of Two Candidates for admission into the Society were read, and ordered to be suspended.

The following gentlemen, who had been duly elected Members, subscribed the Form No. 2, and were admitted into the Society:—

	Elected.
Wm. Hering, Esq., M.D.	1863, June 17.
T. Du Boulay, Esq	1863, June 17.
W. H. Harrison, Esq	1862, March 19.
G. G. G. F. Pigott, Esq.	1863, June 17.
Wm. H. Yates, Esq.	1863, March 18.

The PRESIDENT delivered the following Inaugural Address:—

GENTLEMEN,—The valuable Reports of our Secretaries and the address of my esteemed predecessor have fully detailed to you the progressive condition of the Society, and that of meteorology in general. It would therefore be an encroachment on your time were I to direct your attention to similar subjects. Perhaps it may be well to consider briefly some of the points in the science which have recently been considered of interest; and if my remarks have a practical bearing in some respects, I trust they may not be considered unworthy of your consideration.

And first I would advert to the subject of the oxidizing agency existing in pure atmospheres—which has been assumed, without sufficient evidence, to be identical with the ozone produced in the laboratory. Ozone artificially prepared can be recognized by the smell and by numerous chemical reactions; while only one similar chemical reaction occurring in the air has led to the conclusion that the agency in the atmosphere and in the laboratory is the same. If, when we employ the term ozone, we restrict the signification to an oxidizing agency in the air, the use of the expression can do no harm, although it would be preferable to indicate the facts without an assumed theory. The presence of nitrous acid in the air, which seems to be frequently produced, according to Schönbein, under new phases by the action of air and water, would produce a similar reaction. Very many other bodies would occasion the same result on ozone-paper. The peroxide of hydrogen, which has been considered by some as identical with artifical ozone, was supposed by Dr. Prout to be present in the air; and he adduced, in support of his theory, the bleaching qualities of dew and of the air itself, the excess of oxygen in the air, beyond what is required by the laws of chemical proportion, and also the large amount of oxygen in snow and rain-water. Now, peroxide of hydrogen, in presence of a slight degree of acidity, either in the air in the form of a nitrogen acid or such as might originate by acetification of the starch in ozone-paper, would immediately liberate the iodine, and produce the ozone-reaction. Much complaint has lately been made of the variable character of ozone-paper. Now it should be borne in mind that the preparation of ozone-test paper is a most delicate chemical experiment. One source of fallacy in the preparation of these tests may be the employment of impure iodide of potassium. This salt is usually made by forming first an iodide of iron, and then decomposing

Plate. XVIII.

Diagram exhibiting Meteorological Phenomena
on 1863. October. 30.
as indicated by self-registering Instruments at the Royal Observatory, Greenwich.

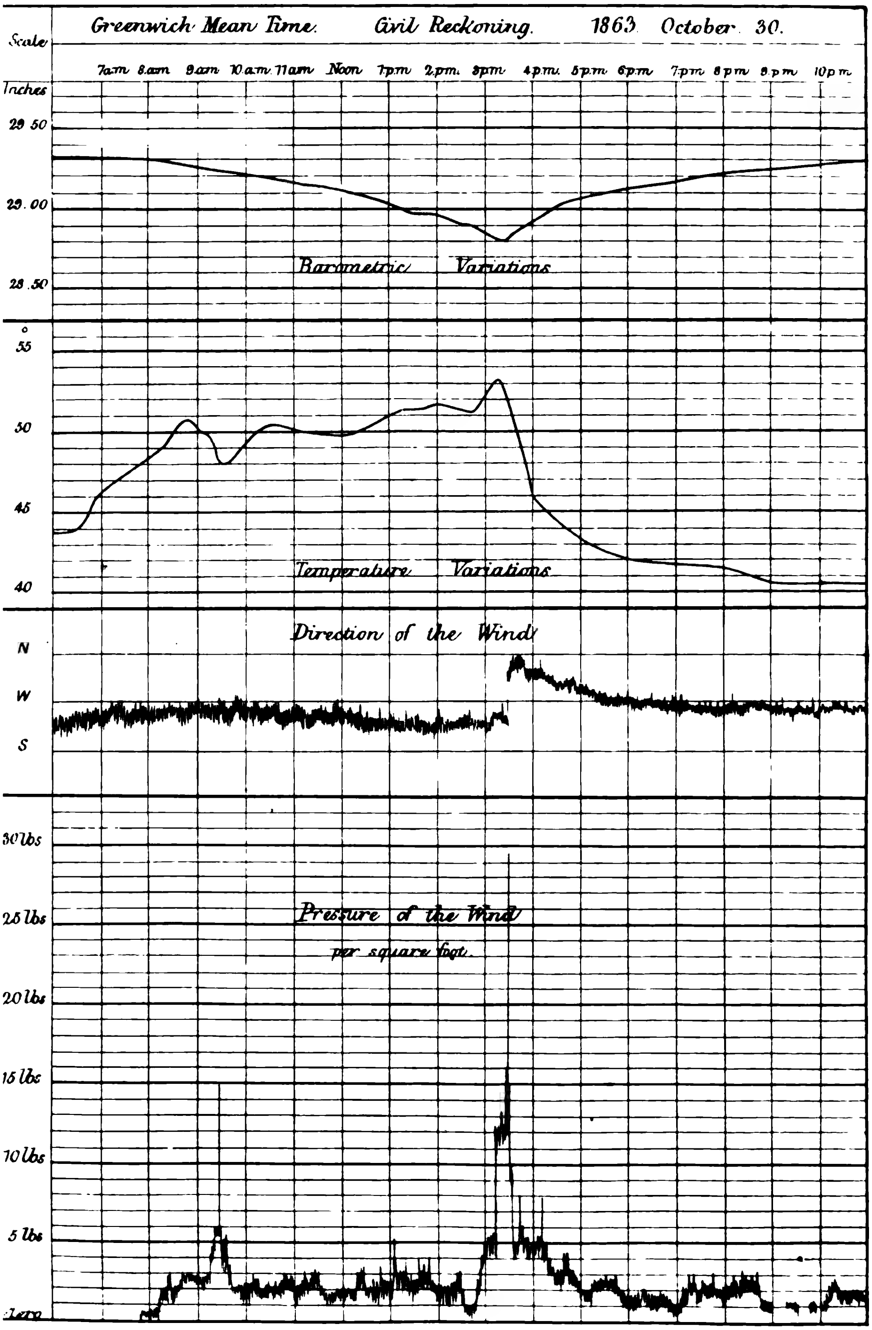
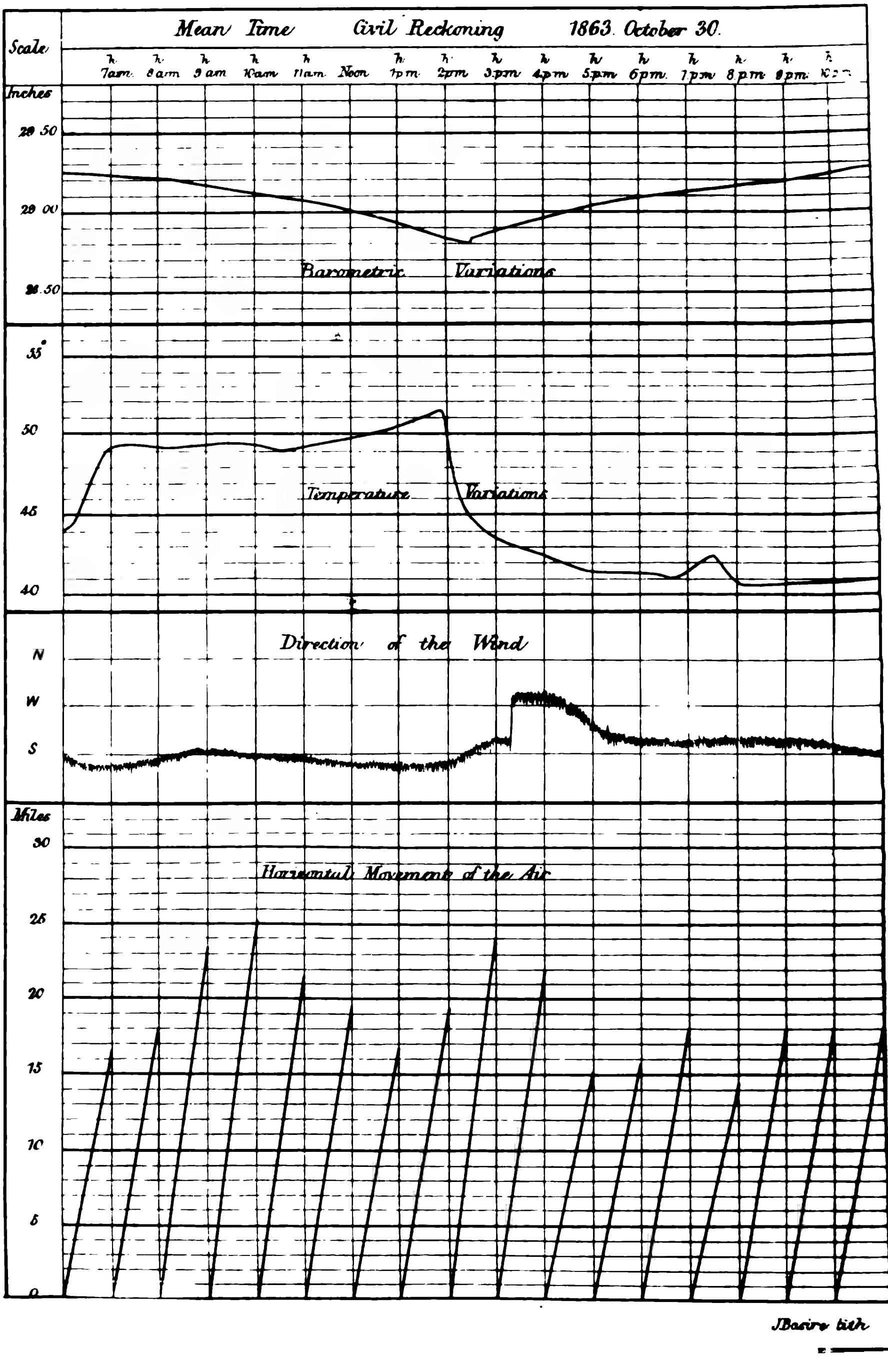


Plate XIX

Diagram exhibiting Meteorological Phenomena on 1863. October. 30. as indicated by self-registering Instruments at the Radcliffe Observatory, Oxford.



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this by carbonate of potash and evaporating. If no precautions are adopted, the resulting crystals are mixed with carbonate of potash, and the iodide is highly deliquescent and alkaline; but the crystals of iodide of potassium are, when pure, scarcely deliquescent. They may be procured free from carbonate of potash, by precipitating the carbonate by means of iodide of barium, filtering, and evaporating. The residue is then boiled in alcohol and crystallized. The crystals will be found then neutral, and not deliquescent, and in a condition to form ozone-test paper.

It seems necessary, in experimenting upon atmospheric ozone, that some check should be kept upon the detection of ozone by the use of iodide papers by other sensitive means. Thus slips of paper, impregnated with a solution of protosulphate of manganese, become brown in presence of ozone, by the formation of a dark peroxide of manganese.

The conditions and properties of atmospheric vapour have recently attracted intense interest.

Richman (Nov. Com. Petrop. i. p. 284, 1747–48) observed that a thermometer withdrawn from water fell 4 or 5 Centigrade degrees below the temperature of the air, but supposed it to be due to the saline particles of the air uniting to the water on the thermometer like a freezing-mixture. Mairar (Traité sur la Glace, 1749, p. 248) attributed the lowering of the temperature to the violent agitation to which the water is exposed. Cullen, however, was the first (Edinb. Essays, Physical and Literary, 1756, read 1st May 1755, p. 145) who gave the true explanation of the wet-bulb thermometer, by ascribing its descent to evaporation; he showed the influence of various volatile fluids on the thermometer, and produced ice, *in vacuo*, by means of nitric ether; he used mercurial, spirit and air thermometers. Daniel described his hygrometer in 1820 (Roy. Inst. Trans.). Gay-Lussac (Ann. de Chim. xxi. p. 82, 1822) resumed these experiments, and used a wet- and dry-bulb thermometer; he was followed by August in 1825 (Pogg. Ann. v. 69), and Regnault in 1843 (Ann. de Chim. xv. p. 129).

The use of the wet- and dry-bulb thermometers has been of the greatest service in enabling us to procure upon an extensive scale information respecting the conditions of the atmosphere in relation to vapour. Perhaps some excuse may be found for the following details respecting the history of this instrument. For the introduction of this simple method of observation in this country, science is indebted to John Abraham Mason, M.D. He visited Madeira in 1834–35 for the benefit of the climate, and, from the

delicacy of his health, he naturally turned his attention to the varying states of the atmosphere. During his residence in that island, he constructed the well-known Mason's hygrometer, and made an extensive series of experiments in every variety of circumstance, comparing it with Leslie's Connel's hygrometers; and on his return to this country he wrote a valuable paper, descriptive of the instrument and of his experiments, which he intrusted to me in April 1836, and which I published with a plate*. The deductions from his observations in Madeira appeared in his joint work with Mr. Blewitt on that island. The instrument gradually came into use; but it received the greatest impulse from the labours of Mr. Glaisher, who modified the instrument, and by his accompanying tables enabled us readily to obtain extensive results. The last portion of Dr. Mason's paper was published in August 1836; and he sunk under phthisis, on the 20th October following, a few days after reaching Nice. This tribute to the memory of a truthful observer and excellent man, though late, I most willingly pay in a meeting of the cultivators of meteorology.

One of Dr. Mason's directions in deducing the dew-point from an observation by his hygrometer was, to ascertain, in each case, the lowest limit of refrigeration by a strong current of air passed over the surface of the moistened bulb. From his observations, he was enabled to construct a table, in which he attached to each degree of dryness observed a corrective column, containing the excess of refrigeration to be added. These experiments were made in this way:—He placed two hygrometers of similar construction upon a table in the middle of a large room; they each indicated, for example, 3° of dryness, the difference of temperature between the dry- and wet-bulb. He then subjected one of the wet-bulbs to the strongest current he could produce by a pair of double bellows; and he found that he could reduce its temperature below that of the other only 5°. By a series of experiments, he found that this depression bore a proportionate progressive increase by equal increments of dryness. At 6° of dryness, the excess of refrigeration was 1°; at 12° it was 2°, and so on. He drew the deduction that the temperature of the moistened bulb, when thus reduced to its utmost limits of refrigeration, indicates the exact mean between the temperature of the air in the shade and the dew-point. As the degree of dryness is one of the most important considerations in respect to the feelings of invalids

* Thomson's Records of General Science, iv. p. 23, 1836. See also Farr's British Medical Almanack, 1837.

or delicate constitutions, the effect of placing the human body in a rapid current of air will tend very much to augment any disagreeable sensations. Unless, however, the hygrometer is placed under similar conditions, it will fail to indicate the true cause of the abnormal influence experienced by the invalid. In the *leste*, or dry wind of Madeira, the hygrometer often indicated 24° degrees of dryness, while two hours before the setting in of the wind the dryness was only 20°. At our watering-places and invalid-stations this correction may be worthy of attention, especially when we indicate the degress of dryness as an element in the sanitary value of the locality. It may be a matter of question whether our methods of distinguishing very minute quantities of vapour in the higher regions of the atmosphere are sufficiently delicate, since Mr. Rush found, in ascending to 19,440 feet, a stratum of air 8600 feet (or 1·63 miles) thickness which was absolutely dry, and Mr. Glaisher, in his remarkable ascent on the 5th of September, found the degree of humidity from 10,071 feet up to 28,990 feet "very small indeed," and he adds that from 21,000 to 26,000 feet the elastic force was less than ·017. But as water evaporates at all temperatures, however low, it is evident that, although the varying temperature of the higher regions of the atmosphere must give rise to alternating conditions of condensation and evaporation of the aqueous fluid, we can scarcely conceive that vapour does not diffuse to as great an elevation as atmospheric air. Of course this view takes it for granted that we still hold in science that vapours diffuse by the same law as gases; and it receives confirmation by the observation of Mr. Glaisher, who, when elevated several miles, saw cirri apparently as distant as when viewed from the surface of the earth. The existence of these clouds at such altitudes seems to support the view that vapour diffuses to the same extent as air, since there is no recent fact calculated to throw any doubt on the opinion that cirri (as, it is believed, originally suggested by Mariotte) consist of crystals of ice. It might be objected that, if they are so constituted, they ought immediately to fall by their gravity into the lower regions of the atmosphere, and that cirri should be of very ephemeral existence. This no doubt does occur; the crystals are precipitated, but their place is immediately occupied by others from the condensed vapour. It is one of the characters of clouds, which remain hovering where they are formed, that their internal constitution is constantly changing, while their external configuration remains permanent. I have never seen this better illustrated than

in the case of the tablecloth-cloud when it settles on Table Mountain, at the Cape of Good Hope. The wind then blows from the S.E., the whole sky on every side is completely clear, the sun shines in full perfection; but upon the mountain a mass of white fleecy clouds is settled, with a flat upper outline. There is no peculiarity to windward, as the vapour is deposited invisibly; but on the leeward side the fleeces of cloud seem to dash over the precipitous cliff, and instantly disappear in the atmosphere. Yet there is no change in the external form of the cloud. When viewed, however, by a glass it is seen to be in a state of internal commotion. The cirri, when similarly examined, are observed to consist of curls which are in a continual state of agitation, and therefore correspond with their usually received constitution. If Dalton's theory, then, be correct, that "the lowest particle of vapour sustains the weight of all the particles of vapour above it, and the weight of no other, and that every particle of gas is equally pressed in every direction, but the pressure arises from the particles of its own kind only, and that they diffuse by their repulsive power," it is not easy to admit that a portion of the atmosphere between the earth and the cirri clouds should be destitute of all vapour to the depth of 8000 feet. Mr. Glaisher, it has been already stated, does not go so far as Mr. Rush in affirming that the air is absolutely destitute of vapour at 12,440 feet. His experiments seem to recognize the presence of a small portion; and this would be in accordance with the usually received opinion of the theory of vapour. But if there be an extensive stratum of air absolutely dry, as stated by Rush, how are we to account for the existence of vapour, as proved by the presence of cirri clouds, at a much greater elevation?

From these and other considerations, it would be necessary to fall back on the view of Halley, that there is a connexion between air and vapour in evaporation, that the diffusion of vapour does not follow the law of elastic gases, and that the theory of the independent existence of an atmosphere of aqueous vapour would be no longer tenable. But the whole subject of the diffusion of elastic fluids, particularly of vapours, is in a doubtful condition. Dalton held that no mutual action existed between the particles of two elastic mixed fluids; while Bunsen concludes that "the particles of different gases exert the same pressure on each other as the particles of similar ones," and, from his experiments, that "the diffusive interchange of different gases does not occur in the relation of the inverse square roots of the specific gravities" (Gasometry, p. 216). Until, therefore, the law of the diffusive power of

gases and vapours is established by further research, the theory of atmospheric vapour must remain in an uncertain state.

A peculiarity in the atmosphere of cities, which was pointed out by me in 1854, in London*, is that the air, when washed in distilled water, communicates an intensely acid reaction from the presence of sulphuric and sulphurous acids, derived from the sulphur of coals and gas. When a quantity of this acid air is passed through distilled water, a copious growth of fungi is soon perceptible in the water; and frequently foreign bodies are detained, which have been previously dispersed even through the external air. This acid fluid seems peculiarly adapted for the development of these inferior organisms; but, in the experiments quoted, no animal life could be detected when the air outside of a building was examined. In the air of a cholera ward, full of patients, not only were portions of the dresses of the occupants of the ward detected within a foot of the ceiling, but particles of hair, wool, fungi, and sporules, and also Vibriones, a class of animated beings among the lowest in the scale, without mouth, alimentary canal, or any particular organ. We may infer, therefore, that the germs of these animals were diffused through the air, and that nitrogenous or animal matter, capable of nourishing them, likewise was dispersed through the same atmosphere. These facts, it may be suggested, are calculated to throw light on the production or intensity of disease in close and ill-ventilated apartments; for the atmospheres examined were situated in a well-ventilated hospital. In the atmosphere of sewers, the water through which the air was passed proved to be highly alkaline from the presence of ammonia; fungi were present, but were less readily developed than in the acid atmospheric air; while Vibriones were abundant, and were rapidly propagated. The presence of the volatile alkali is the cause of the rapidity of the diffusion of a sewer-atmosphere or of an atmosphere in which animal matter is allowed to putrify—ammonia being the first product of the decomposition of nitrogenous bodies. Ammonia must therefore be viewed as the most efficient carrier of organic molecules into the atmosphere, which alone are capable of producing disease possessed of a regular type. That the ammonia of the air is derived from terrestrial organic sources is confirmed by the fact that when rain-water is examined, the ammonia contained in it always exhales an animal odour; and the salt of ammonia formed by adding an acid to rain-

* General Board of Health, Report of the Committee for Scientific Inquiries, presented to both Houses of Parliament, Appendix, p. 9.

water and evaporating, possesses a brown organic aspect. We can understand, therefore, without difficulty, how the poison of typhus fever, where ammonia is exhaled from the lungs in a greater degree than in health, and likewise in an abnormal manner from the skin, should be readily propagated in a close atmosphere; and how ventilation can most efficiently remove this volatile vapour as fast as it is formed, and prevent the air from stagnating and imparting its baneful influence to everything surrounding it. During last year, in Paris, somewhat similar experiments have been made on external air, and similar organisms detected*, the object being to inquire into the truth or falsity of the doctrine of spontaneous generation.

Another foreign body frequently found in the atmosphere near the sea is common salt; and it is no doubt accompanied by a minute portion of the other salts of sea-water. Dr. Smollett, in 1765†, states that, while resident at Nice, when there was a strong breeze from the sea, the surface of his body was covered with a salt brine very perceptible to the taste. Dr. Dalton has told us how, during a westerly gale, his windows at Manchester, nearly thirty miles from the sea, have been coated with salt. I have detected common salt in recently fallen rain on rocks on the summit of Goat Fell, in Arran, at an elevation of nearly 3000 feet above the level of the sea; while I have found no streams, which I have examined on that island at their origin on the summits of granite rocks, to be free from this constituent of salt water. With a gale from the sea, therefore, we may expect salt water in a finely divided state to be conveyed into the atmosphere over the land; but we are not in a condition to attribute with certainty to its presence any beneficial or baneful influence upon health. Dr. Smollett, who was an invalid, states that on the day he tasted the brine in the air, his health was partly benefited and partly prejudiced under the existing circumstances. That sea-water, when drifted by the wind in the form of finely divided spray, has a prejudicial action on some forms of vegetation, may be well seen on the western coasts. Trees placed without any shelter on the shore, exposed to the full force of an Atlantic gale, seem to have little chance of attaining any altitude; but when sheltered in a valley, or situated on the eastern side of a ridge, they thrive without difficulty. On the western shore of Luce Bay, in Wigtonshire, thriving plantations grow; but the trees forming the front rows

* Pasteur, Annales de Chimie, lxiv. p. 5, 1862.

† Travels through France and Italy, vol. ii. p. 22, 1778.

exposed to the spray are inferior to those in the rear and at a higher elevation. It is of importance, therefore, to escape the deteriorating influence of the salt water driven through the air, that the trees should be thickly planted. It must be remembered, however, that it is as neutral common salt, just as we find it in the sea, that this substance is diffused through the air, and that we know of no power in the atmosphere capable of resolving it into its elements. The salt therefore is useful as a manure, when introduced by the roots of certain plants and trees; but when applied in quantity to the delicate apparatus of the leaves, which perform the threefold office of digestion, respiration, and nutrition, appears to destroy their texture in a corrosive manner, and consequently their functions.

Meteorology, in its relations to atmospheric temperature, promises to throw definite light on the animal functions under different conditions. The cause of summer diarrhœa, for example, used to be attributed to irregularities of dieting during its prevalence; but the predominance of this complaint among the infantile population seemed to throw doubts on this conclusion. The increase, too, in the number of the subjects of this disease as the summer temperature rises, and the decline with the colder season of the year, seem to prove that temperature is the exciting cause of this abnormal condition of the system. As no returns of the cases which occur of this complaint, until they have proved fatal, are readily available, we are obliged to be content with an amount of data too limited perhaps to afford trustworthy deductions; but the general tendency is sufficiently apparent from the following facts, from the district of St. Marylebone, brought under my notice during one year:—

1859.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1. Mean temperature	40°·5	42°·9	46°·6	47°·6	51°·5	62°·3	67°·1	64°·2	56°·7	50°·9	41°·1	37°·1
2. Days × by temperature.	1142°	1201°	1305°	1332°	1442°	1744°	1879°	1807°	1587°	1425°	1150°	1038°
3. −1142	1	+59	+163	+190	+300	+602	+737	+665	445	+283	+ 8	−104
4. Additional days of heat ÷ by mean temperature	1	1·4	4	4·7	7·4	14·8	18·2	16·4	11·	7·	•	
5. Cases of Diarrhœa	76	104	129	143	160	544	2293	1934	737	227	139	139
6. Cases for each degree of heat	...	74	32	30	21	36	126	118	67	32		

1. In this Table (see also Plate XVII.) we have, in the *first* line, the mean temperature of the month.

2. In the *second*, the *accumulated* temperature, obtained by multiplying the mean temperature by the number of days in each month.

3. The *third* line gives the increase of *accumulated* temperature for each month, and gradual decrease, obtained by taking the *accumulated* temperature of January as unity, and deducting it from the other accumulated temperatures.

4. The *fourth* line represents the *additional* days of heat thrown into each month, as compared with January. These are arrived at by dividing the excess of *accumulated temperature* by the mean temperature of each month. Thus, February contains nearly one and a half days of heat more than January; March four days more heat than January, &c.

5. The *fifth* line gives the cases of diarrhœa.

6. The *sixth* line is arranged by dividing the cases of diarrhœa by the additional days of heat in line *four*.

We see from the Table, that the excess of accumulated heat in June was double that in May; the cases rose from 160 to 544. Again, in July the excess of accumulated heat was nearly four days above that of June; and the cases increased to 2293: while in August they fell to 1934; and the excess of accumulated heat diminished by nearly two days. We cannot expect an exact numemerical relation between the heat and the disease, because the cases are limited, and the influence of the heat is cumulative from one month to another, which of course cannot be precisely estimated when acting on vital beings endowed with a nervous resisting-power varying in each individual.

One of the most interesting facts in confirmation of this view of atmospheric temperature upon the human system, and of the disturbance of the normal diffusion of the animal fluids, is the established conclusion which has been arrived at in Calcutta, that the hot season is the least favourable for vaccination*. In 10,102 cases vaccinated in the cold season (mean temperature $=75^{\circ}\cdot6$) in that city, from the 1st of November 1853, to the 31st of March 1854, 96·07 per cent. were successful, 1·67 were partly successful, and 2·25 per cent. failed. On the other hand, in the hot season, with a mean temperature of $86^{\circ}\cdot5$, between the 1st of April and the 30th of September 1854, 2100 were vaccinated; of these only 73·76 per cent. were successful, 4·90 per cent. partially, and 21·33 per cent. were failures†.

These considerations, therefore, show the important bearing of meteorology on health, and how much of the animal nature is dependent on purely physical conditions. In this country during hot weather, the direction of the fluids of the body is disturbed in those affected with diarrhœa. The fluids which, in the healthy state, pass from the intestinal canal into the blood, have in the abnormal state produced by heat their action reversed, and they then pass from the blood into the intestinal canal.

In conclusion, I would congratulate the Members on the prosperity of their Society, and on the prospect of its attaining even a more prominent position than it now occupies, should the suggestions of the Council be carried out.

* Dr. Duncan Stewart and Mr. Bedford, 'Notes on the Vaccine Establishment in Bengal,' Calcutta, 1854, p. 4.

† The mean temperatures are taken from Mr. Glaisher's valuable Report of the Indian Army Commission.

XLIV. *On the Gale of October* 30, 1863.
By James Glaisher, Esq., F.R.S., Secretary.

On October 30 a great storm, although of short duration, swept over Greenwich, during which the wind reached a pressure of 29½ lbs. on the square foot, exceeding all previous pressures that had been experienced since the establishment of the self-recording instrument at the Royal Observatory, in the year 1841. To illustrate this point more completely, I will here reproduce a Table of extreme pressures of the wind in each year from 1841, which appeared in a paper "On the Pressure of the Wind," which I laid before this Society at the commencement of the year 1862*.

Table I. Showing extreme Pressures of the Wind per square foot at the Royal Observatory, Greenwich, from 1841 to 1863.

Year.	Month	Extreme Pressure.	Year.	Month.	Extreme Pressure.
		lbs.			lbs.
1841.	November	24	1853.	February	15
1842.	March	21	1854.	February	17
1843.	January	25	1855.	April	15
1844.	March	17	1856.	May	16
1845.	January	13	1857.	March...............	13
1846.	January	12	1858.	December	16
1847.	February	18	1859.	November	20
1848.	February and June	13	1860.	February	28
1849.	February	22	1861.	February	25
1850.	February	25	1862.	October	22
1851.	August	11	1863.	October	29½
1852.	December	24			

From this Table, it is readily seen that, previous to the gale of 29½ lbs. of the present year, the greatest pressure had been 28 lbs. in 1860, and the next heaviest 25 lbs., which was experienced in each of the years 1843, 1850, and 1861. It is a somewhat remarkable fact also, in connexion with this Table, that throughout the whole range of years 1841 to 1863, the two last years, 1862 and 1863, are the sole instances of the occurrence of the extreme pressure of the year in the month of October. Yet the mere fact of the pressure in this storm exceeding all previous pressures, as far as authentic records extend, would not alone have induced me to make any lengthened communication to this Society; but, by carefully comparing the records of the several self-registering instruments, it was found that the great gust was coincident with the

* *Vide* Proc. Meteor. Soc. Vol. I. p. 85.

following phenomena, viz. the lowest reading of the barometer, a rapid decline of temperature, and an instantaneous change of 90° in the direction of the wind, in direct motion, or following the course of the sun. These various records have been reproduced on a single sheet, in order that the coincidence of these phenomena may more readily be seen, and are comprised in the Diagram forming Plate XVIII., comprehending all the changes between 6^h A.M. and 11^h P.M.

The following facts may be briefly deduced from these curves, viz. the barometer at first fell slowly from 29·32 in. at 6^h A.M. to 29·30 in. by 8^h A.M., then decreased with great rapidity to 28·80 in. by $3^h\ 30^m$ P.M.: a rapid rise followed; the reading 28·85 in. was reached only 9 minutes after the minimum reading, increased to 29·06 in. by $4^h\ 40^m$ P.M., and finally reached 29·30 in. by 11^h P.M.

The temperature of the air rose from 43°·8 at 6^h A.M. to 50°·8 by $8^h\ 40^m$ A.M., then fell 3° by $9^h\ 30^m$ A.M., rose to 50°·5 by $10^h\ 30^m$ A.M., varied but little from 50° till noon, rose to 51° by 1^h P.M., and to 51°·5 by 2^h P.M., fell to 51°·3 by $2^h\ 40^m$ P.M., and then rose to the maximum value, 53°·3, by $3^h\ 15^m$ P.M.; the rapid fall then ensued, reached 46° by 4^h P.M., 43° by 5^h P.M., 42° by 6^h P.M., and 40°·6 by 9^h P.M.

The direction of the wind was S.W. till noon; S.S.W. till $3^h\ 30^m$ P.M., then changed to W.N.W., gradually returned to W.S.W. by 6^h P.M., and to S.W. by 11^h P.M. The wind first commenced blowing forcibly a short time before 8^h A.M., reached a force of 3 lbs. on the square foot by 9^h A.M., increased in a gust to 15 lbs. by $9^h\ 30^m$ A.M., then generally blew with a force varying between 1½ lb. and 4 lbs. till 3^h P.M., greatly increased in force after this time, reaching 6 lbs. at $3^h\ 16^m$ P.M., 12 lbs. at $3^h\ 20^m$ P.M., 17 lbs. at $3^h\ 29^m$ P.M., and finally 29½ lbs. at $3^h\ 30^m$ P.M.*, then suddenly decreased in amount, pressing occasionally with a force of 8 lbs. till $4^h\ 10^m$ P.M.; and from $4^h\ 30^m$ P.M. to 11^h P.M. the force generally varied between 1 lb. and 3 lbs., with occasional periods of no perceptible pressure.

The Oxford curves, forming Plate XIX. (for which I am indebted to the kindness of the Rev. R. Main, M.A., Director of the Radcliffe Observatory), confirm the Greenwich changes in a remarkable manner, although the Oxford changes precede those at Greenwich by about one hour. Mr. Main observes, however, that "the storm of wind was not very violent at Oxford, and there was no

* At New Cross Station, 1·6 miles W. of the Royal Observatory, a long range of engine-shed was blown down, burying several men. It fell, as nearly as can be ascertained, at 3.40 P.M.

violent gust like that experienced at Greenwich;" indeed the same fact may easily be seen by reference to that portion of the Oxford Diagram which exhibits the velocity of the wind. It will be seen that although the air was in rather more rapid motion from 2^h to 3^h P.M. than for three or four preceding hours, yet the increased rate of travelling was not at all commensurate with what we should expect from a gust of such extreme violence as the one recorded at Greenwich.

TABLE II. Showing the amount of Change in Direct Motion (or in the order N., E., S., W. &c.) of the Wind during sudden gusts, as deduced from the Anemometric Records at the Royal Observatory, Greenwich, between the years 1855 and 1863.

Year.	Month, Day, Hour, and Minute.	Direct Change.	Amount of Change.	Pressure during Gust.
	d h m		°	lbs.
1855	March ... 3 2 30 P.M....	W. to N.W.	45	4½
1856	May ...... 18 1 45 P.M....	S.W. — W.S.W.	22½	5 to 10
	July ...... 8 0 15 A.M....	W. by S. — W.N.W.	33¾	3½
	November 24 11 40 P.M....	N.W. — N.	45	7
1859	January... 23 6 0+ P.M.	W. — N.N.W.	67½	13
	December 6 6 45 P.M....	S. — S.W.	45	10
1860	January... 1 11 15 P.M....	S.S.W. — S.W.	22½	9
	" ... 15 9 0 P.M....	S.W. — W.	45	3
	February 19 5 20 P.M....	W.N.W. — N.W.	22½	18
	July ...... 29 3 30 P.M....	N. — E.	90	3
	September 1 6 45 P.M....	S.W. — W.	45	2
1861	March ... 11 6 45 P.M....	W.N.W. — N. by E.	78¾	4
	May ...... 2 5 30 P.M....	N.N.W. — N.N.E.	45	5
	" ...... 4 0 45 P.M....	N.N.E. — E. by N.	56¼	9
1862	July ...... 10 7 30 P.M....	W. — N.W.	45	4
	" ...... 16 4 20 P.M....	W. — N.	90	5
	October... 12 6 40 P.M....	S.W. — W.N.W.	67½	5
	" ... 17 11 0 A.M....	S.W. — W.	45	5
	" ... 20 2 45 A.M....	W. — N.W.	45	8
	" ... 24 3 30 P.M....	W. by S. — N. by W.	90	8
1863	August ... 17 3 30 P.M....	W.S.W. — W.N.W.	45	4½
	" ... 19 6 0 P.M....	W. — N.	90	5
	" ... 25 4 15 P.M....	S.S.W. — W.S.W.	45	4
	September 20 0 10 A.M....	W.S.W. — W.N.W.	45	4
	" 21 2 15 P.M....	W.S.W. — N.W.	67½	2
	October... 29 3 45 P.M....	S.W. — W.S.W.	22½	14
	" ... 30 3 30 P.M....	S.S.W. — W.N.W.	90	29½

But, confining ourselves to the Greenwich records, the simultaneity of the change of the direction of the wind with the greatest pressure in the gust at $3^h\,30^m$ P.M. naturally directed attention to the records of preceding years, wherein it was found that in continuous heavy gales of wind the direction was invariably continuous, but that in detached gusts (such as the one under consideration) which frequently accompany sudden showers of rain the wind generally shows a tendency to alter its direction by a small amount, following the course of the sun. Several instances of this kind have been selected, and are embodied in Table II.

This Table sufficiently indicates that such changes are by no means unfrequent, the singular fact in connexion with them being that the change always takes place in one direction, that is, following the sun; indeed, through all the records which I have examined, I have been unable to detect any change in the opposite or retrograde direction. For this curious law I have not as yet attempted to assign any determinate cause.

But the further discussion of this singular storm must be deferred until I have collected materials from which its course and extent may be more certainly traced. In the present paper my aim has been to bring prominently forward the extreme value of self-registering instruments in recording and preserving changes of so rapid a nature that they would otherwise be unavoidably lost; and I earnestly trust that the firstfruits of this paper may be the establishment of many other self-recording instruments.

The Diagrams by which this paper is illustrated were reduced and drawn by Mr. W. C. Nash, of the Royal Observatory, Greenwich.

Note on the Gales of December 2 *and* 3, 1863.

During the early morning hours of the 2nd, the wind blew briskly from the S.S.E., recording pressures of 1½ lb. to 6 lbs. At 9^h A.M. the wind turned to S., and shortly after to S.S.W., and continued blowing lightly from this quarter till 2^h P.M. By $2^h\,30^m$ P.M. the wind turned to W., and suddenly increased in force, in a few minutes reaching 9 lbs. on the square foot, and varied between 5 lbs. and 9 lbs. till $2^h\,50^m$ P.M., the direction meanwhile veering to N.W.; at $2^h\,50^m$ P.M. a pressure of 16 lbs. was experienced, and at $2^h\,55^m$ P.M. one of 22½ lbs. From $2^h\,57^m$ P.M. to $3^h\,20^m$ P.M. the pressure generally continued between 8 lbs. and 16 lbs., with one gust to 20 lbs. After $3^h\,20^m$ P.M. the wind declined greatly in force, press-

ing with forces varying between 2 lbs. and 7 lbs. till 7^h P.M., and from $\frac{1}{2}$ lb. to 1 lb. till 8^h P.M.

By 8^h P.M. the direction of the wind had returned to W.S.W.; and from 8^h P.M. till $4^h\ 30^m$ A.M. on the 3rd, it blew alternately from W.S.W., S.W., S.S.W., and S.S.E., with but little force; but after $4^h\ 30^m$ A.M., with a heavy fall of rain, the direction returned to S., and it again commenced blowing with great and increasing force. From $4^h\ 30^m$ A.M. till 8^h A.M. the pressures varied between 1 lb. and 7 lbs.; it then increased in violence after 8^h A.M., reaching a pressure of 21 lbs. on the square foot at $8^h\ 10^m$ A.M., the direction at the same moment changing from S.W. to W.

From $8^h\ 15^m$ A.M. to 7^h P.M. the wind continued from the W., and constantly pressed with forces of 4 lbs. to 12 lbs. After 7^h P.M. it veered to N.W., and continued from this quarter till after midnight, the pressures between these times varying between 1 lb. and 6 lbs.

XLV. *Method of Determining the Path of a Meteor.* By ALEX. HERSCHEL, Esq. Communicated by JAS. GLAISHER, Esq., F.R.S., Secretary.

MR. GLAISHER exhibited a model (by A. Herschel, Esq.) showing the method of determining the path of a meteor. It consisted of a block of wood as base, upon which was pasted a map. Perforations were made into the wood at places where the meteor was observed, at inclinations corresponding to the angular height and azimuth of the meteors; wires of sufficient length were inserted into these holes, from which perpendiculars could be dropped. The assemblage of wires, at the first and last appearances, showed the places where the meteor was first and last seen, and the distance from the earth of these places, with their latitude and longitude. The joining of the two places of intersection showed the path of the meteor.

Mr. Glaisher then said:—"On the 9th and 10th of August 1863, observations were made at the Greenwich and Cambridge Observatories, at Cranford and Euston-Road Observatories and at Hawkhurst, for determining the heights and velocities of the annual shooting-stars of the period. The following meteors were simultaneously observed on these evenings at one or more of these

observatories and at Hawkhurst. The full particulars of the observations are contained in the catalogue accompanying the Report of the British Association for 1863.

"In Table I. the stations of observation are represented, for shortness, by their initial letters—*Cambridge*, Ca.; *Cranford*, Cr.; *Euston Road* (London), E.; *Greenwich*, G.; and *Hawkhurst*, H.; and the numbers in the first column of the first and following Tables refer to the order of appearance of the meteors, and to their places on the Chart, Plate XX.

"The mean height of disappearance, from Table II.*, is 57·7 miles above the level of the sea. The mean direction of their flight is from azim. 222° W. fr. S., alt. 28°, which at the mean instant of the appearances was near the bright star γ of Perseus, in Æ 43°·1, N. decl. 50°·8.

"The mean velocity, from Table III., is 39 miles per second; but if we exclude the two velocities of 61 and 70 miles per second, obtained separately for meteor No. 12, as evidently affected by errors of observation, the mean geocentric velocity of the fifteen remaining observations is 34·4 miles per second, which agrees closely with results hitherto accepted. The remaining columns of this Table contain the illuminating power of each meteor during the period of its visible flight. In the last column but one, this quantity is expressed by the volume of ordinary coal-gas which would be required to supply an equal illumination for an equal space of time by its ordinary combustion in atmospheric air (see note *ad fin.*). The heat of this combustion, converted into 'foot-pounds,' furnishes the numbers for the last column in the Table. These represent the mass of meteoric matter, moving with a geocentric velocity of 30 miles per second, which such an amount of free caloric, if applied directly, would be able to arrest upon its flight. The weights may be taken to represent roughly the meteoric particles as they existed before their dissolution, effected by the heat and pressure of their contact with the air. The use of the oxyhydrogen flame of lime, or the flame of the electric arc as a medium of comparison in this mode of treating the subject, in place of ordinary gas-flame, would probably confirm the opinion that even smaller quantities of meteoric matter than those now indicated are sufficient to produce the sparks of light called shooting-stars."

* Four duplicate determinations of the meteors Nos. 3, 10, 12, and 13, included in this and the succeeding mean values, are here omitted for brevity.

Table I.

No.	Date. 1863, Aug.	G. M. T.	Station	Began Azim. W. fr. S.	Began Alt.	Ended Azim. W. fr. S.	Ended Alt.	Station.	Began Azim. W. fr. S.	Began Alt.	Ended Azim. W. fr. St.	Ended Alt.
	d	h m s		°	°	°	°		°	°	°	°
1	9	9 53 0	H.	266·0	83·0	30·2	62·5	E.	219·0	61·0	252·3	43·2
2	9	10 18 0	H.	115·5	71·7	70·7	41·7	E.	352·8	72·0	337·8	39·2
3	10	9 21 35	H.	79·2	49·2	51·0	20·8	E.	37·0	58·0	34·7	22·2
4	10	9 36 30	H.	60·0	42·0	50·2	22·8	E.	41·0	41·0	39·7	22·7
5	10	9 46 10	H.	230·5	20·7	241·2	12·0	Ca.	265·3	23·0	281·5	11·5
6	10	9 53 28	H.	99·5	61·3	83·7	51·0	Ca.	21·8	47·7	29·5	39·5
7	10	9 56 45	H.	136·3	31·8	121·3	22·7	Ca.	91·8	49·0	79·2	29·8
8	10	10 4 20	H.	172·7	16·8	161·2	13·0	Ca.	176·6	29·1	155·6	22·7
9	10	10 6 0	H.	221·5	61·0	212·5	82·5	E.	256·0	62·0	213·7	59·0
10	10	10 6 35	H.	60·0	68·8	39·8	40·3	Cr.	337·5	53·3	1·0	33·8
11	10	10 9 0	H.	78·0	73·2	65·2	47·2	E.	8·0	69·3	22·7	45·2
12	10	10 11 30	H.	221·5	55·8	207·5	83·3	G.	249·0	57·5	307·8	57·0
13	10	10 18 50	H.	140·2	65·0	77·0	50·2	Cr.	275·0	78·0	14·0	55·5
14	10	10 33 29	H.	133·0	72·7	92·0	67·0	Ca.	157·8	43·3	3·8	33·5
15	10	10 40 20	H.	218·7	58·7	219·4	69·3	Ca.	316·7	47·8	333·7	40·0
16	10	10 41 30	H.	93·8	43·2	84·0	33·3	Ca.	44·0	39·0	49·0	30·0
17	10	10 46 46	H.	204·7	28·7	199·0	27·2	Ca.	233·5	39·8	233·5	42·3
18	10	10 52 26	H.	155·5	47·5	130·0	45·8	Ca.	32·8	74·3	44·2	54·3
19	10	11 7 1	H.	100·2	31·0	85·7	18·5	Ca.	53·2	30·5	44·3	15·7
20	10	11 9 0	H.	85·5	64·7	56·7	32·8	G.	27·3	66·5	34·7	33·3

Table II.

	Beginning.				End.			
No.	Lat. North.	Long.	Height in miles.	Dist. from Hawkhurst.	Lat. North.	Long.	Height in miles.	Dist. from Hawkhurst.
	° ′	° ′		miles.	° ′	° ′		miles.
1	51 2	0 39 E.	86	86	50 42	0 18 E.	58	66
2	51 10	0 2 W.	75	79	50 48	0 36 W.	44	67
3	50 53	0 55 W.	72	95	49 54	1 56 W.	53	143
4	50 6	2 5 W.	114	173	49 33	2 39 W.	73	188
5	52 14	3 8 E.	55	154	51 55	2 51 E.	25	120
6	51 9	0 33 W.	87	99	50 56	1 3 W.	84	108
7	52 14	1 20 W.	71	135	51 57	1 57 W.	52	134
8	53 34	0 2 W.	55	188	53 32	0 52 W.	42	188
9	51 48	1 30 E.	131	149	51 8	0 35 E.	66	66
10	50 51	0 0	63	68	50 20	0 27 W.	53	83
11	50 56	0 15 W.	109	114	50 42	0 41 W.	62	83
12	51 51	1 45 E.	122	146	51 6	0 35 E.	55	55
13	51 26	0 2 W.	79	87	50 57	0 37 W.	58	76
14	51 13	0 9 E.	64	66	51 3	0 2 W.	53	58
15	51 30	1 7 E.	72	84	51 16	0 48 E.	60	64
16	51 7	1 35 W.	85	124	50 50	2 24 W.	83	151
17	53 4	2 8 E.	86	179	52 49	1 33 E.	68	149
18	51 57	0 9 W.	76	103	51 41	0 43 W.	71	99
19	51 18	1 52 W.	62	120	50 56	1 55 W.	35	111
20	50 59	0 24 W.	86	95	50 14	1 18 W.	65	122

Table III.

No.	Length of path in miles.	Duration (Hawkhurst) in seconds.	Velocity (geocentric) miles per second.	Direction of flight from		Apparent brightness (Hawkhurst).	Light of meteor at 1 mile compared to full moon.	Supply of coal-gas for luminous effect equal to that of the meteor.	Weight of meteoric matter arrested at 30 miles per sec., concluded from heat evolved. Avoirdupois.		
				Azim. W. fr. S.	Alt.						
				°	°			cubic feet.	lb.	oz.	grs.
1	41	1·0	41	218	40	Altair	0·07	13			118
2	48	1·4	34	222	40	Altair	0·07	16			153
3	84	3·0	28	218	13	Jupiter	8·27	4264	5	11	171
4	71	1·7	38	249	42	Jupiter	19·02	5560	7	7	88
5	46	...	...	193	40	Venus	13·70	2356	3	2	214
6	26	1·0	26	234	6	α Persei	0·07	12			108
7	38	1·0	38	235	32	α Persei	1·13	19			182
8	39	1·3	30	262	18	Sirius	5·16	1153	1	8	315
9	53	1·2	33	219	47	Sirius	1·69	348		7	203
10	46	...	...	209	13	Sirius	0·83	142		3	29
11	54	1·6	33	228	62	α Lyræ	0·18	49		1	19
12	100	1·4	71	220	42	Sirius	1·47	355		7	264
13	48	1·5	32	215	26	Sirius	4·85	1251	1	10	354
14	18	0·8	23	212	34	α Persei	0·02	4			31
15	25	0·5	50	216	29	α Persei	0·03	3			28
16	41	...	...	238	2	Cor Caroli	0·06	10			[illegible]
17	34	...	...	233	33	Venus	23·55	4049	5	6	
18	31	...	...	232	9	Altair	0·13	22			
19	38	...	...	186	46	Sirius	1·95	335			
20	69	1·8	38	241	18	Sirius	1·72	532			

Table I.

No.	Date. 1863, Aug.	G. M. T.	Station	Began Azim. W. fr. S.	Began Alt.	Ended Azim. W. fr. S.	Ended Alt.	Station.	Began Azim. W. fr. S.	Began Alt.	Ended Azim. W. fr. St.	Ended Alt.
	d	h m s		°	°	°	°		°	°	°	°
1	9	9 53 0	H.	266.0	83.0	30.2	62.5	E.	219.0	61.0	252.3	43.2
2	9	10 18 0	H.	115.5	71.7	70.7	41.7	E.	352.8	72.0	337.8	39.2
3	10	9 21 35	H.	79.2	49.2	51.0	20.8	E.	37.0	58.0	34.7	22.2
4	10	9 36 30	H.	60.0	42.0	50.2	22.8	E.	41.0	41.0	39.7	22.7
5	10	9 46 10	H.	230.5	20.7	241.2	12.0	Ca.	265.3	23.0	281.5	11.5
6	10	9 53 28	H.	99.5	61.3	83.7	51.0	Ca.	21.8	47.7	29.5	39.5
7	10	9 56 45	H.	136.3	31.8	121.3	22.7	Ca.	91.8	49.0	79.2	29.8
8	10	10 4 20	H.	172.7	16.8	161.2	13.0	Ca.	176.6	29.1	155.6	22.7
9	10	10 6 0	H.	221.5	61.0	212.5	82.5	E.	256.0	62.0	213.7	59.0
10	10	10 6 35	H.	60.0	68.8	39.8	40.3	Cr.	337.5	53.3	1.0	33.8
11	10	10 9 0	H.	78.0	73.2	65.2	47.2	E.	8.0	69.3	22.7	45.2
12	10	10 11 30	H.	221.5	55.8	207.5	83.3	G.	249.0	57.5	307.8	57.0
13	10	10 18 50	H.	140.2	65.0	77.0	50.2	Cr.	275.0	78.0	14.0	55.5
14	10	10 33 29	H.	133.0	72.7	92.0	67.0	Ca.	157.8	43.3	3.8	33.5
15	10	10 40 20	H.	218.7	58.7	219.4	69.3	Ca.	316.7	47.8	333.7	40.0
16	10	10 41 30	H.	93.8	43.2	84.0	33.3	Ca.	44.0	39.0	49.0	30.0
17	10	10 46 46	H.	204.7	28.7	199.0	27.2	Ca.	233.5	39.8	233.5	42.3
18	10	10 52 26	H.	155.5	47.5	130.0	45.8	Ca.	32.8	74.3	44.2	54.3
19	10	11 7 1	H.	100.2	31.0	85.7	18.5	Ca.	53.2	30.5	44.3	15.7
20	10	11 9 0	H.	85.5	64.7	56.7	32.8	G.	27.3	66.5	34.7	33.3

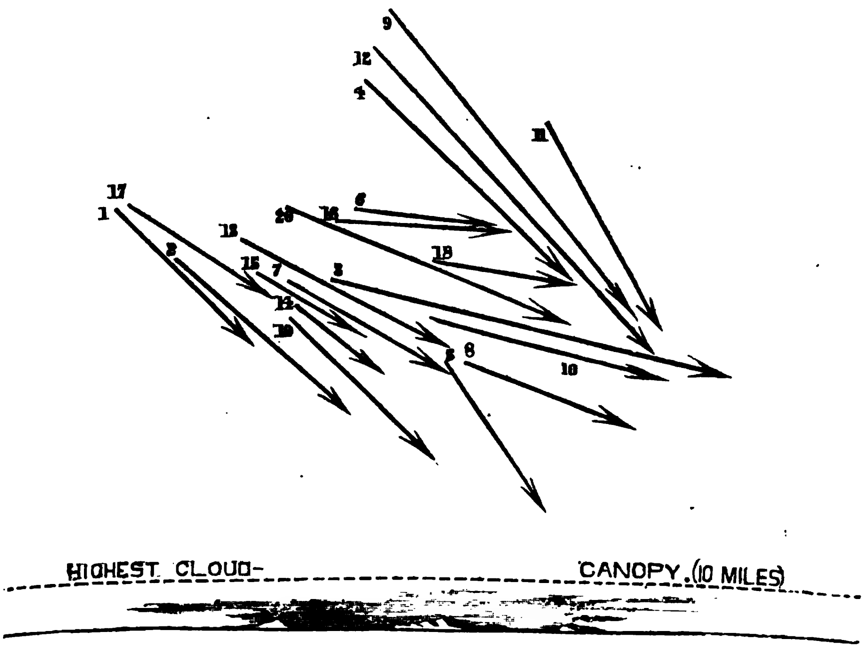
Table II.

No.	Beginning. Lat. North.	Long.	Height in miles.	Dist. from Hawkhurst.	End. Lat. North.	Long.	Height in miles.	Dist. from Hawkhurst.
	° ′	° ′		miles.	° ′	° ′		miles.
1	51 2	0 39 E.	86	86	50 42	0 18 E.	58	66
2	51 10	0 2 W.	75	79	50 48	0 36 W.	44	67
3	50 53	0 55 W.	72	95	49 54	1 56 W.	53	143
4	50 6	2 5 W.	114	173	49 33	2 39 W.	73	188
5	52 14	3 8 E.	55	154	51 55	2 51 E.	25	120
6	51 9	0 33 W.	87	99	50 56	1 3 W.	84	108
7	52 14	1 20 W.	71	135	51 57	1 57 W.	52	134
8	53 34	0 2 W.	55	188	53 32	0 52 W.	42	188
9	51 48	1 30 E.	131	149	51 8	0 35 E.	66	66
10	50 51	0 0	63	68	50 20	0 27 W.	53	83
11	50 56	0 15 W.	109	114	50 42	0 41 W.	62	83
12	51 51	1 45 E.	122	146	51 6	0 35 E.	55	55
13	51 26	0 2 W.	79	87	50 57	0 37 W.	58	76
14	51 13	0 9 E.	64	66	51 3	0 2 W.	53	58
15	51 30	1 7 E.	72	84	51 16	0 48 E.	60	64
16	51 7	1 35 W.	85	124	50 50	2 24 W.	83	151
17	53 4	2 8 E.	86	179	52 49	1 33 E.	68	149
18	51 57	0 9 W.	76	103	51 41	0 43 W.	71	99
19	51 18	1 52 W.	62	120	50 56	1 55 W.	35	111
20	50 59	0 24 W.	86	95	50 14	1 18 W.	65	122

Table III.

No.	Length of path in miles.	Duration (Hawkhurst) in seconds.	Velocity (geocentric) miles per second.	Direction of flight from: Azim. W. fr. S.	Direction of flight from: Alt.	Apparent brightness (Hawkhurst).	Light of meteor at 1 mile compared to full moon.	Supply of coal-gas for luminous effect equal to that of the meteor.	Weight of meteoric matter arrested at 30 miles per sec., concluded from heat evolved. Avoirdupois. lb.	oz.	grs.
				°	°			cubic feet.	lb.	oz.	grs.
1	41	1·0	41	218	40	Altair	0·07	13			118
2	48	1·4	34	222	40	Altair	0·07	16			153
3	84	3·0	28	218	13	Jupiter	8·27	4264	5	11	171
4	71	1·7	38	249	42	Jupiter	19·02	5560	7	7	88
5	46	...	...	193	40	Venus	13·70	2356	3	2	214
6	26	1·0	26	234	6	α Persei	0·07	12			108
7	38	1·0	38	235	32	α Persei	1·13	19			182
8	39	1·3	30	262	18	Sirius	5·16	1153	1	8	315
9	53	1·2	33	219	47	Sirius	1·69	348		7	203
10	46	...	...	209	13	Sirius	0·83	142		3	29
11	54	1·6	33	228	62	α Lyræ	0·18	49		1	19
12	100	1·4	71	220	42	Sirius	1·47	355		7	264
13	48	1·5	32	215	26	Sirius	4·85	1251	1	10	354
14	18	0·8	23	212	34	α Persei	0·02	4			31
15	25	0·5	50	216	29	α Persei	0·03	3			28
16	41	...	...	238	2	Cor Caroli	0·06	10			96
17	34	...	...	233	33	Venus	23·55	4049	5	6	341
18	31	...	...	232	9	Altair	0·13	22			209
19	38	...	...	186	46	Sirius	1·95	335		7	76
20	69	1·8	38	241	18	Sirius	1·72	532		11	175

Fig. 1.



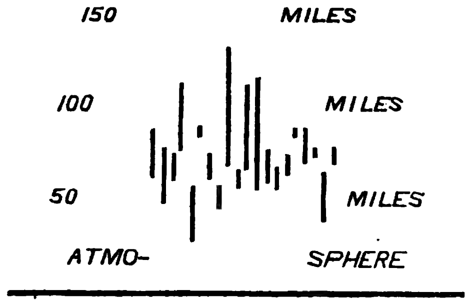
(15,760 feet.)

Visible heights of Shooting Stars compared with a Standard Geological Scale.

(August 10th, 1863.)

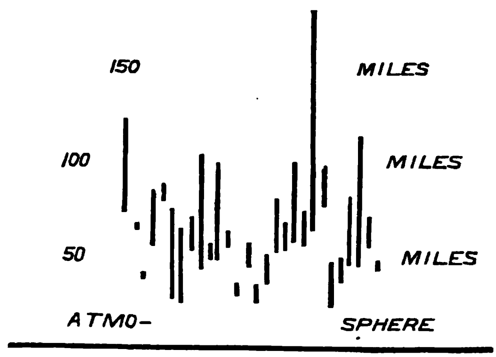
The luminous trajectories by which these meteors approached the earth were exalted far above the heights accessible to man, either upon the sides of mountains or in the more adventurous ascents of a balloon. In figs. 1 & 2 they are represented upon

Fig. 2.



Mr. Nasmyth's excellent "geological standard scale," and, more concisely, in a diagram of elevations above the sea-level of the earth. A diagram (fig. 3) similar to the last, prepared by Dr. Heis, admits

Fig. 3.



a direct comparison of the heights of twenty-eight meteors observed by himself at Münster, and by other observers elsewhere, on the evening of the same date, between 9^h and 11^h P.M. The accordance between the results is so marked, that in future a region between fifty and a hundred miles above the surface of the earth must be admitted to be eminently devoted to the exhibition of these displays. The lower boundary of this region is well defined, and the upper boundary by no means extended (as the de-

ductions of meteorologists have not unfrequently led us to suppose) from the earth upward into unlimited space.

Note.—The light of full moon has been equated by Sir John Herschel ('Cape Observations,' p. 353 *et seq.*) to 6852 × *Sirius*, 54,816 × *α Lyræ*, 78,770 × *Altair*, 160,000 × *α Persei*, and to 318,900 × *Cor Caroli*. It is further compared in this place to a flame consuming 4¼ cubic feet per hour of ordinary coal-gas at a distance of fifteen yards, or to a flame consuming 17·2 cubic feet of coal-gas per second at the distance of a mile.

According to Despretz (quoted by Brande, 'Manual of Chemistry,' p. 275), a single cubic foot of ordinary coal-gas containing 63 grains of pure hydrogen and 147 grains of pure carbon would raise the temperature of 677 lbs. of distilled water 1° Fahrenheit by its combustion. The mechanical equivalent of this quantity of heat is most nearly 522,000 foot-pounds, of which 55,675 represent the potential energy of a grain weight of matter animated by a velocity of thirty miles per second. A single cubic foot of coal-gas, on this assumption, would suffice to arrest the motion of 9·378 grains weight of matter moving with a geocentric velocity of thirty miles per second. The weights of the last column are therefore found when the numbers of the preceding column are multiplied by the constant factor 9·378 grains.

XLVI. *On Meteorites.* By Professor G. GIUSEPPE BIANCONI, of Bologna. Translated and communicated by H. S. EATON, Esq., M.A., Librarian.

Bologna, 11 August, 1863.

SIR,—A splendid Bolide shone forth last night, the 10th of August 1863. I saw it on the occasion of my observing, with my son, the shooting-stars from the top of my country-house on the River Samoggia, halfway between Bologna and Modena.

At half-past nine this Bolide appeared at a little distance to the east of the Polar Star; and it directed its course toward the constellation of the Great Bear, terminating in that of Arcturus. At first it was small and moderately bright. Its splendour increased at the first third of its course. There it assumed a dazzling brilliancy. Its light, white at first, passed to an azure-violet of marvellous beauty, accompanied by an intense light, extremely vivid.

Shortly after, in approaching Arcturus, it grew dim, and at length entirely disappeared. Its disk, at the maximum of its incandescence, equalled one-sixth of the lunar disk. A luminous atmosphere accompanied it, at first small, very abundant and which expanded in the middle*, and at length it became attenuated near the end of its course.

The path of the bolide, as far as one could judge, was rectilinear. In the same straight line the tail appeared, which remained after the disappearance of the bolide. It was spindle-shaped—that is to say, very large in the middle and attenuated at the two extremities. These two parts vanished almost at the first moment; thus the tail, by the gradual shrinking of the two ends, became so modified that the middle only remained visible, for about three entire minutes. This remaining middle portion became flexuous and serpentine.

No noise reached our ears: all was in silence. Our eyes, enchanted by the beauty of this spectacle, did not observe the ground. Persons who were in the thoroughfares saw all the country illuminated. Stronger than the light of the moon, the brightness afforded by this meteor caused the shadows of trees and surrounding objects to be very distinct.

I am waiting till the end of the season of shooting-stars in order to address to you some observations on the vapours which attend their course, and which have relation to the conjectures I have published on the sublimation of the matter of asteroids kindled in our atmosphere.

G. Giuseppe Bianconi.

The following paper is the promised communication:—

I trust that the British Meteorological Society will favourably regard some observations that I have made during the last periodical return of shooting-stars. These observations tend, it seems to me, in some measure to advance the conjectures broached in my pamphlet, "*Del calore prodotto per l'attrito fra fluidi e solidi in rapporto colle sorgenti termali e cogli aëroliti,*" which I have had the honour to present to the said Society. There I have spoken of a priority of the experiments made at Bologna in 1839 and 1840 over those made by Messrs. Joule and Thomson in 1843, on the heat obtained by the friction of liquids with solids; and I have also ex-

* Here we saw luminous diffusions, which spread some little way from the incandescent disk.

pressed some opinions respecting meteorites, bolides, and shooting-stars; and, in particular, I have advanced an hypothesis to which I now have an opportunity of reverting.

The experiments of Mr. Joule have given a high degree of probability to the opinion that the incandescence exhibited by bolides and shooting-stars is the effect of the caloric produced by the friction of the asteroids with the air of our atmosphere, when they traverse it. The brilliancy and the light given out by shooting-stars and bolides are thus the effect of this new calorific source, except so far as other concomitant causes may contribute to it—that is to say, the compression of the air, electricity, &c. I have thought that this is not the only effect of this heating cause.

The rapidity is probably not confined to producing incandescence and superficial fusion of aërolites, or, taking it more broadly, of the asteroids. I have thought that there is a much more important effect—that of an extremely high temperature, capable of producing a sublimation or volatilization of the superficial matter of the asteroids, consequently of giving rise to two other phenomena:—1st, to a subtraction of matter at their angles, and the retunding of those aërolites, which become thus blunted and rounded; 2nd, to the nebulosity which surrounds these bodies when they traverse our atmosphere, which forms the trail that generally marks the track of falling stars.

These two conjectures have been dwelt upon, if I am not mistaken, in the last observations I made with the kind cooperation of my confrères, Prof. Respighi and Dr. Casoni. It remains with me, however, to point out that these are only the first steps that have been attempted in this inquiry, which I hope to be able subsequently to advance in the coming meteor-season of November. I am now going to report the facts, so as to be able to revert to them afterwards in their application.

On a sky the clearest I have ever seen, assisted by my son, during the early hours of the night, on the evenings of the 4th, 6th, 7th, 10th, 11th, and 12th of August, I observed several shooting-stars and a few bolides. The principal one, which travelled from the Pole Star to Arcturus, was described in the memorandum that I had the honour of addressing to the British Meteorological Society. I shall not here speak of their number, direction, or any other particulars unconnected with the subject of which I am going to treat. Unless a deceptive appearance has misled me, I have noticed that the velocity of the routes of luminous bodies in the atmosphere is not the same in all, nor always equal in the same

body. It has been observed for a long time that luminous bodies (bolides) appear to move more slowly than shooting-stars (Humboldt's 'Cosmos,' pp. 3, 476, ed. Bruxelles). *Now* this distinction between these two classes of phenomena is no longer admissible. At the same time a sensible difference arises when we compare the course of a shooting-star with that of a bolide to nearly the same place. The bolide on the 10th of August presented to us what appeared to be clearly a difference in the velocity of the first and last parts of its course. The lengthened path which it traversed gave us the chance of observing, without any ambiguity, that its speed slackened perceptibly after the first half of its route. The same appearance was noticed on the 6th of August, at 9 P.M., in a little bolide which travelled from the zenith to the south. It appeared about as large as Venus.

I do not know whether any one has made any further observations on this very important point. The trail of light which accompanies bolides and shooting-stars, presents many remarkable differences. The extinction of the tail in the latter is generally very rapid. In the twinkling of an eye a shooting-star is past, and the tail vanishes as quickly. At other times it has rather longer duration, lasting one or two minutes or sometimes more. The tail of the bolide on the 10th of August lasted three minutes in all. As the disappearance was not simultaneous, we could see that the two extremities were first extinguished, the middle part being the last to disappear.

This fact has been often proved, but especially in the case of the bolide quoted. After its disappearance, the tail was very long at first, afterwards it became shortened at each end—the centre, as we have already said, lasting the longest. Whilst I was observing, with my son, in the country on the Samoggia, Dr. Casoni was also observing at the University Observatory. Our observations upon the tracks of light left by bolides and shooting-stars agreed as well in the phases of extinction as in other particulars. That which seemed to be a luminous atmosphere did not appear from the beginning of its course; it was after a part of its route that it seemed to commence. Then it increased rapidly in bulk to a maximum towards the middle of its path. Then it lessened by degrees, and quite disappeared some distance from the end of the bright path*. Its form was spindle-shaped, dilating from the commencement, like that of the bolide of Quenggock, in Pegu.

* An incorrect expression has slipped into the pamphlet quoted, '*Del Calore*,' &c., p. 39, with regard to the uniformity of combustion.

The disappearance of the tail thus commences in the thinnest part; and the portion which remains is that whose bulk is of the largest dimensions. "I have observed," writes Dr. Casoni, "that the luminous tail generally appears smaller at the beginning and the end, and that it increases towards the middle; it is most voluminous and abundant in the centre. When it has arrived at a maximum of its diffusion, it begins to decrease, until it vanishes away some distance from the point where the bolide disappears." The tail generally appears rectilinear; and when it vanishes quickly, it does not change its form. The tail of the bolide on the 10th of August, after being diminished by the extinction of its two extremities, changed its form very slowly. At first rectilinear and larger in the middle, it afterwards appeared shortened, undulated, and serpentine. It resembled fig. iv. 1, given by M. Schmidt (Haidinger, Sitzung., Oct. 3, 1861). It must be observed that the changes of shape took place some time after the luminous body had disappeared and passed far on its path. The luminous matter that the burning asteroid left behind it, indicating its path, was the only circumstance and the only phase of the phenomenon that could be submitted to careful observation or to the telescope. This will doubtless be a subject of subsequent observations.

Professor Respighi, Director of the University Observatory, has been kind enough to observe, with a five-foot comet-finder, the tracks left by meteors on the 10th of August—the only evening on which he was disengaged.

"Some of the tails disappeared the first minute. Others, especially those which appeared the least elevated, lasted longer. They presented also different aspects: a tail, at first rectilinear and very much condensed, would become flexuous and undulated; at the same time diffusing itself, it would break into segments, some of which would conglomerate and look like little bright clouds of the nebulæ of a comet. These appearances lasted a long time—sometimes ten or twelve minutes, the splendour gradually fading, and the tail changing in shape, size, and position, while others did not change at all. Sometimes the thickest part, viz. the centre, remained visible to the naked eye for some moments. We saw one which divided into two rectilinear parallel branches very near together, which again became undulated and flexuous; it then broke into fragments, the principal of which united and formed a nebulous cloud, that lasted a considerable time."

To these observations by Prof. Respighi, we may add the singular

contortions and variations described by M. J. Schmidt (Haidinger, *l. c.*) :—

"Up to a certain point the tail of a meteor shortens and diminishes according to the intensity of light. The bolide of the 10th of August, which was at first small and white, then of an ordinary brightness like that of a shooting-star, became of a brilliant whiteness after one-third of its course. At this point the luminous atmosphere became very abundant and extensive. A dazzling greenish incandescence, which afterwards changed to a light but very bright purple, formed the decoration of the meteor in the middle of its course; then it faded, and at last disappeared. Changes thus take place in the light, as well as in the luminous atmosphere. These two effects of the passage through the air of the planetoids present an increase and diminution of intensity, which deserve to be further studied."

I am now going to advance some considerations resulting from these observed facts, as far as my knowledge will allow me.

Admitting, as a general principle, that projectiles moving with planetary swiftness may happen to pass through our terrestrial atmosphere, they doubtless traverse it according to their original direction, so long as they are not hindered by any obstacle. Joined to the attraction of the earth, one obstacle to overcome, and partly conquerable, is the resistance of the atmosphere itself, varying according to the different density of its strata. The course then of the meteor, supposing it to pass through a central region of our atmosphere, would be retarded in accordance with this power of resistance.

Its course would not, however, be stopped; and its route might be continued to the opposite extremity of the atmosphere, and out again. Another case is possible: a planetoid might either, by the direction of its movement or by the diminution of its speed, caused by gravitation, be directed towards the surface of the earth, and there fall on a spot a long way from the bright apparition*. I have examined some cases of this kind in my pamphlet '*Del Calore*,' &c. A calorific friction takes place in this case; but its

* "We might believe," says Mr. Tyndall, "that the greater number of aërolites are dissipated by heat, and the earth thus subjected to a terrible bombardment" (*Heat considered as a Mode of Motion*, 1863, p. 11). Another cause available for this proposition is noticed by Prof. Respighi:—"The different density of the aërial strata may repel even the planetoids, so as to push them out of the atmosphere. Here is an explanation of the opposite argument, that the grandest appearances of failing stars are not accompanied by the fall of aërolites."

effects cannot be the same in every point of the path traversed. In the first place, they will be very limited, either on account of the rarefaction of the external atmospheric strata, or because the heating can only take place by gradual accumulation, rapid as we may suppose it to be. The point where the resistance comes to a maximum, and where the speed is nearly at its greatest, is also that at which the strongest action and reaction take place, and where lies the full complement of conditions necessary to the highest effect of this friction. It is also at this point—the very middle of the route—that may be seen the maximum light and the maximum produce of vapour, also the largest transverse dimensions of the tail. The sidereal velocity being thus hindered, the meteor pursues its path, still continuing to slacken its speed, owing to the surrounding atmosphere. One of the elements of the calorific friction thus beginning to cease—the heat, light and brightness also begin to fade, and at last it all passes into obscurity and disappears. Once admit that the heat of friction is, as I suppose, important enough to sustain the fusion of the surface, the incandescence of the planetoid, and besides all this the sublimation of the melted matter which goes to form the tail, and we see that the phenomenon can only take place where the heating conditions have power to produce this sublimation. It will begin gradually, at first not so ample, becoming very abundant in the middle, then diminishing again, and just ceasing when the course of the meteor is slackened and incapable of producing the necessary heat.

This reasoning will not fail when we avail ourselves of another element in the origin of the luminous vapours, *i. e.* the subtraction of melted particles from the surface of the planetoid by the force of the draught of air encountered by the body in its passage. Perhaps some superficial erosions of aërolites are thus caused. The duration of a greater or smaller portion of the bright tail is probably explained under these conditions.

The heat arrives at its greatest intensity in the central part of its path. If the heat is thus accumulated and concentrated in the centre of the tail, it is evident that this part must necessarily be longest in cooling. It will also appear to the eye of an observer to be extinguished later than the beginning and the end; as the heat of these parts is the least intense, so they will be the last to disappear. We ought certainly to have a precise idea of the duration of very intense heat in a volume of air heated with such astonishing rapidity.

I do not know, on the other hand, whether the dimensions of this kind of sublimated cloud have ever been calculated. That which accompanied the meteor of the 10th of August was, as far as I could judge, of very large dimensions, especially in its last stage. I could see that its bulk was enormous; but we must leave it to philosophers to determine whether, in such a mass, we might imagine a reservation of heat sufficient to support the combustion of particles evaporated from the surface of the meteor.

We find in the undulated form of the luminous tail of the bolide, in the figures drawn by Mr. Schmidt and in Prof. Respighi's observations, some indication of the movements that the molecular mass of the tail experiences when it is left in the lurch by the flight of the meteor. We see there the movements peculiar to heated vapours left in the middle of the atmosphere—how they whirl and curl, in dependence on two conditions:—1st, the tranquillity or otherwise of the surrounding fluid; 2nd, the disturbance caused by the projection of the luminous body. Perhaps it will be yet observed (as I have foreseen, but which I nevertheless dared not affirm) that the luminous trail which remains quietly suspended up in the air has, together with a gentle upward motion, undulatory and other movements.

Perhaps there may be observations of this kind, consigned to some corner of the archives of science, which I have not yet had an opportunity of discovering.

In short, these few observations lead us to conclude:—1st, That heat produced, as we are authorized to believe, by the friction of asteroids against the atmosphere is not only calculated to produce incandescence and fusion, but that it attains to a higher degree—*that* of causing a sublimation of the surface-matter of asteroids, which sublimation or volatilization forms a luminous atmosphere around the falling body, of a volume varying according to the intensity of the source of heat. 2nd. That this luminous atmosphere (the tail), left to itself, disappears partially and by degrees, principally on account of its dimensions, temperature, and density; and, whilst its particles accumulate concentrically, it contracts and changes form with the variations peculiar to vapours.

The influence of electricity, or any other cause connected with the phenomena exhibited by burning planetoids, may partially modify these conclusions.

August 30, 1863.

XLVII. *Rain at New Moon.* By J. PARK HARRISON, Esq., M.A.

(Note.)

THIS was a short notice showing different conclusions, depending on the different modes of combining certain observations of rainfall recorded at Geneva.

BOOKS AND NOTICES.

XVII. *Further Researches on the Auroræ Boreales and the Phenomena which attend them.* By AUG. DE LA RIVE (Phil. Mag. June 1862, pp. 8; and Archives des Sciences Phys. et Nat., Nouvelle série, tom. xiv. pp. 121–135, 1862, June).

THIS is the substance of a memoir read before "la Société de Phys. et d'Hist. Nat. de Genève, 1862," Feb. 6. The author considers that his theory* "is remarkably confirmed by observations made during the last few years, especially by those of Mr. Walker, on the currents exhibited by telegraphic wires, notwithstanding that this learned observer has deduced from them conclusions unfavourable to this theory." He calls attention to the coincidence of aurora borealis and australis, and that it is an atmospheric phenomenon — that the ocean-vapours conduct positive electricity to the upper strata of the atmosphere, which is carried by the trade-winds toward the polar regions, forming a positive envelope to the earth. The earth and the upper rarefied air, being conductors, correspond to the two plates of a condenser, and the lower stratum to the dielectric. The dielectric is thinner near the poles, where therefore condensation is greatest and discharges more frequent; and they "should take place almost simultaneously at the two poles, since, the earth being a perfect conductor, the electric tension should be nearly the same at each,"—not instantaneously, but by successive discharges, the medium having low conducting-power.

Alluding to the variations in intensity and direction of earth-currents, and that, as observed, they are derived currents collected by large sheets of metal in moist earth, "it will be seen that the plates, being speedily polarized under the chemical action of the current passing through them, must," according to our author, "develope in the wire which unites them an opposite current as soon as that whence they derived their polarization ceases." When the negative electricity of the earth discharges itself at the poles, and meets the positive there accumulated, two positive earth-currents occur from the poles towards the equator, with us from

* *Vide* Proceed. Meteor. Soc. vol. i. p. 74; *ib.* p. 161.

N. to S. But if the discharge is at the S. pole only, there is no N. to S. current with us, but a S. to N. current of lower value; hence the S. to N. currents in the telegraphic wires—added to which is the current from the secondary polarity of the earth-plates, already referred to, and which "must produce a current almost as strong." But discharges rarely cease at one pole to occur exclusively at the other; the results in question are rather due to difference of intensity, and are less decided, and accompanied by numerous oscillations.

By passing a Ruhmkorff discharge through rarefied air and through a saline solution, derived currents are collected out of the latter, and the copper plates employed acquire secondary polarities. A magnetized needle, suspended over mercury in the circuit, obeys the electro-dynamic laws.

M. De la Rive prepared a globe of wood, with iron poles projecting, and contained in glass cylinders in which a vacuum could be made, so that using a Ruhmkorff coil he could obtain the auroral discharge at each pole, and by magnetizing the iron could produce motion and rotation of the light. By placing a band of moistened blotting-paper round the equator, and another, at right angles, from pole to pole, he caused currents to traverse the globe, from which he could collect derived currents by the application of copper plates, and could lead them to a distant galvanometer. By examining these currents he obtained illustrations of "what takes place in nature," and they explain "all the variations in the movements of the galvanometer placed in circuit of telegraphic wires, which accompany so faithfully the different phases through which pass the electric discharges constituting the auroræ boreales and australes." The disturbances of the magnetometers, "being the result of the direct action of the terrestrial currents upon the magnetic needle, are independent of the secondary polarities, which play an important part in the currents of telegraphic wires."

The apparatus employed by M. De la Rive was made at Geneva, by M. Eugène Schwerd, a German artist, in the manufactory of Prof. Thury. An engraving of it is given at p. 126 of 'Les Archives des Sciences Phys.,' Nouvelle période, tom. xiv., June 1862. In a note in 'Les Archives' he mentions that M. Blavier, like Mr. Walker, cannot attribute the S.N. currents to secondary polarity; because currents of polarization are barely sensible during ordinary telegraphic transmissions. "But this objection is not conclusive, seeing that these transmissions take place by means of instantaneous currents, which in general produce only polarizations that are scarcely sensible, whilst earth-currents are continuous and have a duration of some minutes—at least of one minute. In this case the currents to which the secondary polarities give rise are almost as strong as those that have produced the polarities."

XVIII. *On the probable Causes of the Earth-currents.* By the Rev. H. LLOYD, D.D., D.C.L. &c. (Royal Irish Acad., 1862, June 23, pp. 6.)

IN his previous communication* to the Royal Irish Academy, he had "endeavoured to prove that the diurnal changes of the horizontal needle were the result of electric currents traversing the earth's crust," and that the laws of these currents "corresponded with those of magnetic changes;" but he had "refrained from offering any conjecture as to the origin of the currents themselves," which must be a pure hypothesis till confronted with facts. By the rules of inductive philosophy, the more proper course is to ascertain the *laws* of the diurnal changes of earth-currents by inference from the magnetic phenomena they produce, before proceeding to their *causes*. The principal features common to all the observed phenomena are—that the point to which the resultant earth-current is directed follows the sun, although not at a uniform rate, being directed with us towards E. about 10.30 A.M., S. 2.30 P.M., W. 7 P.M., its *maximum* intensity being at 1.30 P.M., and its *minimum*, which is opposite in direction, at 1.30 A.M.; and there are two subordinate maxima and intervening minima. Hence the sun being no doubt the primary cause, its mode of agency is the question to be solved. Dr. Lloyd believes, with Dr. Lamont, that the currents are due to the disturbance of the equilibrium of static electricity; he considers, however, these derangements to be simply the effects of solar heat, and not, with Dr. Lamont, results of an electrical force emanating directly from the sun. The known negative state of the earth and positive state of the atmosphere, increasing with the height and varying with the different periods of the day, furnish "means fully adequate to the production of the observed effects." Assuming the sun to produce these variations by its calorific action, the effects will depend on the relative temperatures of surrounding places; and there will be a flow of positive electricity to places most heated; and this accounts for the maximum at 1.30 P.M., the hottest period of the day. The secondary maxima are probably due to differential effects; their epochs correspond with those of the maxima of atmospheric electricity, as deduced by Quételet. "In order to be able to explain the diversity which exists in the magnetic phenomena at different places, we must know something more of the nature of the solar action, and of the mode in which electricity is developed by it."

Whether, as De Saussure taught, the electricity is *developed* by evaporation, the vapour taking up the positive, and the water retaining the negative—or, as De la Rive thinks, it has its origin in chemical actions within the solid crust of the earth, and the positive is simply *transported* by evaporation—it seems to be granted that the separation of the two electricities is the consequence of evaporation. The effect, therefore, "will vary greatly with the distribution of land and water," and will be greatest "at the coasts of the great continents," where, "the evaporation from the surface

* *Vide* Proceed. Meteor. Soc. vol. i. p. 155.

of the sea being much greater than from the land," there is "a flow of electricity *from land to sea*" distinct from that due to the mere position of the sun. This is precisely what happens. The influence of the form of the coast seems to be shown, for instance, in the diurnal curve of the Cape of Good Hope.

Dr. Lloyd abandons his earlier conclusion, "that the direction of the current of greatest intensity is connected with the magnetic meridian of the place;" for it appears from facts "that the currents affect a meridional direction in the higher latitudes, while they are nearly parallel to the equator within the tropics." Many circumstances of the configuration and structure of the earth influence the direction and magnitude of the currents; but "the principal one is that above stated, viz. the distribution of land and water in the vicinity of the place of observation."

The preceding remarks refer to the regular currents: "the disturbance-currents are caused by the rapid recombination" of the two electricities "through the medium of moisture in the lower strata of the atmosphere"—an hypothesis due to De la Rive, though his views of the laws of the resulting currents are inconsistent with the phenomena. The epochs of maxima of the disturbance-currents depend on the sun's hour-angle, and not on the longitude of the place—which accords with the hypothesis that they are due to the meteorological effects engendered by the sun's calorific agency.

The most formidable objection to the hypothesis herein advanced is, "that the regular magnetic changes are greater in summer than in winter, while with the electrical tension and its changes it is the reverse." But "the physical quantity measured by our electrometers is not the *absolute* electric tension, but its *variation with the height*; while the electric changes which engender terrestrial currents are the variations as depending on *horizontal distance*." The author concludes, "It would be of importance, in reference to this inquiry, to institute electrical observations of a totally different kind from any which we now possess, and to measure the differences of tension as depending on horizontal distance. There seems to be no difficulty in the way of such observations, at least none greater than those which present themselves in the ordinary observations of atmospheric electricity; and the results would probably do more to clear up the physical aspect of these complex and interwoven phenomena than any other observational means."

XIX. *On Electrical Currents circulating near the Earth's Surface, and their connexion with the Phenomena of Aurora Borealis.* (Ninth Article.) By Prof. ELIAS LOOMIS ('American Journal of Science,' vol. xxxiv. pp. 34–45. 1862, July).

AT p. 76 of the first volume of the 'Proceedings' is a notice of the eight preceding articles, in the course of which Professor Loomis had concluded that there is a drift of the stream of elec-

tricity "across central Europe in a direction from about N. 28° E. to S. 28° W." He has collected materials for a similar discussion for North America. He shows "in how many cases the maximum deviation of the magnetic needle occurred earlier at Cambridge, Philadelphia, or Washington than it did at Toronto; in how many cases it occurred at the same instant; and in how many cases it occurred later than at Toronto;" and adds that "these observations indicate that the maximum deviations of the magnetic needle advance like a wave over the earth's surface, and that the direction of its motion is from N 68° E. to S. 68° W." in the United States; in like manner he shows "that the minimum deviation of the magnetic needle advances like a wave over the earth's surface, and that the direction of its motion is from N. 69° E. to S. 69° W." He deduced that the velocity of progress of the *maximum* wave was in one part 113 miles, and in another 75 miles per minute; that of the *minimum* wave 156 and 103; their mean 134 and 89 miles per minute. The resultants of direction are—

For Central Europe	Loomis	N. 28° E. to S. 28° W.
For England	C. V. Walker...	N. 42° E. to S. 42° W.
For New York neighbourhood	Loomis	N. 68° E. to S. 68° W.

A list is given of auroras, corresponding with dates of magnetic variations, which indicate a motion more nearly E. and W.; but the general inference is, that "*in the eastern part of the United States the irregular deflexions of the magnetic needle, whether attended or not by any auroral exhibition, are generally propagated in a direction from N.* 68° *E. to S.* 68° *W., and with an average velocity of about* 112 *miles per minute.*"

A list is given of "notices of lateral displacement of the auroral beams;" from which it is deduced "that *the actual motion of the streamers* is from about N.N.E. to S.S.W.," indicating "a general correspondence between the direction of the electric currents which traverse the earth's surface during displays of the aurora and the motion of the auroral beams. In the United States, the former move from about N. 68° E. to S. 68° W., while the latter move from about N. 30° E. to S. 30° W."

XX. *On Earth-Currents during Magnetic Calms, and their connexion with Magnetic Changes.* By Balfour Stewart, Esq., M.A., F.R.S. (read April 6, 1863). Trans. R. Soc. Edinburgh, vol. xxiii. part ii. pp. 355–370.

The observations of earth-currents during magnetic calms, which had been previously made by Mr. C. V. Walker*, were here discussed in connexion with the simultaneous photographic records of the earth's magnetism at Kew Observatory, those currents

* *Vide* Proceed. Meteor. Soc. vol. i. p. 160 and 341.

being separated which were observed at moments of magnetic disturbance.

It was found, in this investigation, that the great characterizing feature of a disturbing force is the large range which it causes between the different values of earth-currents observed on the same line and during the same hour of the day; and that this peculiar action of disturbances on earth-currents does not depend upon the absolute amount of the disturbing force magnetically measured, but rather upon the rapidity with which this force varies.

Mr. Walker's observation, that meteorological conditions, in all probability, influence the values of the currents observed, was confirmed by the results of this paper.

The hypothesis adopted was, that earth-currents are induced currents, due to those changes which are constantly taking place in the magnetism of the earth. This was called the induction-hypothesis; and the results of the investigation were briefly stated as follows:—

1st. The earth-currents observed during periods of magnetic calm follow a well-marked daily law, one feature of which is the small value of those currents collected during the early morning hours: and this admits of being readily explained on the induction-hypothesis.

2ndly. These observations are probably influenced by such meteorological conditions as affect the electrical conductibility of the upper strata of the earth's crust.

3rdly. The values of the earth-currents collected during periods of magnetic disturbance are chiefly remarkable for their great range, with frequent change of sign. This also admits of a simple explanation on the induction-hypothesis.

4thly. This hypothesis would therefore appear to be sufficient to account for all the earth-currents hitherto observed.

XXI. *On the popular Weather-prognostics of Scotland.* By ARTHUR MITCHELL, A.M., M.D., pp. 26. (Reprinted from Edinburgh Phil. Mag. Oct. 1863.)

DR. MITCHELL has made a collection of "Popular Weather-prognostics," under ten heads:—1. Hills or Mountains. 2. Mists and Fogs. 3. Appearance of the Sky. 4. Moon and Sun, Rainbow, Aurora Borealis, Falling Stars, and Thunder. 5. Distant objects seen with unusual clearness. 6. Unusual sounds. 7. Underground Prognostics. 8. Plants. 9. Conduct, Movements, &c., of Animals: (A.) Birds; (B.) Quadrupeds; (C.) Insects, Worms, &c.; (D.) Sensations experienced by Man. 10. Unclassified Prognostics.

There is so large an amount of popular faith in these signs, that it "determines in no small degree the *actions* of shepherds, farmers, seamen, and others, by whom they are trusted in such a manner as to lead either to gain or loss. They either mislead and cause loss of time and property, or they are useful and ready guides, to be

consulted and obeyed with profit. It is this consideration which gives to the study of them a practical value."

The Marquis of Tweeddale, President of the Scottish Meteorological Society, offers "a prize of twenty guineas" "either in the form of a gold medal, a piece of plate, or otherwise, as the successful competitor may desire," "for the best scientific explanation of the prognostics collected by Dr. Mitchell." The papers to be lodged with the Society's Secretary on the 1st of May 1864. Copies of the Prognostics may be had of Messrs. Blackwood, Edinburgh.

SUNDRY NOTES.

18. ROYAL INSTITUTION. 1863, March 20. *Mr. Stewart's Lecture* on Magnetic Disturbances.* (Abstract.)—A bar of steel, when once magnetized, has acquired a tendency to assume a definite position with respect to the earth. But though this is a well-known fact, we are still very much in the dark with respect to its cause. The force with which the earth acts upon the needle is directive merely, that is to say, the needle is neither attracted nor repelled as a whole, but simply twisted round; and in this respect the earth is similar to a very powerful magnet, the pole of which is placed at a great distance from the needle upon which it acts. The position of a magnetic bar is subject to many changes: let us at present consider those abrupt and sudden alterations of its position which are called magnetic storms. During the prevalence of these unaccountable phenomena, the needle is found to oscillate rapidly and capriciously backwards and forwards, being now on the one side and now on the other of its normal or undisturbed position. It may here be remarked that, in the science of magnetism, the needle is regarded merely as a vane which seems to render visible the direction and intensity of that mysterious force which operates through the earth.

Gauss, by observations at Göttingen and throughout Europe, was the first to direct attention to magnetic storms; and after the establishment of the colonial observatories, it was found by General Sabine that the needle in Toronto was affected at precisely the moment when it was disturbed at Göttingen. Subsequent observations have all served to confirm the remarkable fact that these disturbances break out at the same moment over every portion of our globe. But the point of greatest interest is the connexion of these phenomena with our luminary. This has been placed beyond doubt chiefly through the labours of General Sabine, who found at Toronto and elsewhere that magnetic disturbances obey a law of hours. There is, however, a still more interesting and

* Proceedings of British Meteorological Society, vol. i. p. 320.

mysterious connexion than this. Schwabe of Dessau has found that sun-spots have a period of maximum nearly every ten years, two of these periods being the years 1848 and 1859. Now it was likewise found, by General Sabine, that the aggregate yearly value of magnetic disturbances at Toronto attained a maximum in 1848; and it was afterwards found by observations made at Kew, that 1859 (another of Schwabe's years) was also a year of maximum disturbance. These are the general grounds on which we suspect the sun to be the agent which causes magnetic disturbances; but there is also some reason to believe that on one occasion our luminary was caught in the very act.

On the 1st of September, 1859, two astronomers, Messrs. Carrington and Hodgson, were independently observing the sun's disc, which exhibited at that time a very large spot, when about a quarter past eleven they noticed a very bright star of light suddenly break out over the spot, and move with great velocity across the sun's surface.

On Mr. Carrington sending afterwards to Kew Observatory, at which place the position of the magnet is recorded continuously by photography, it was found that a magnetic disturbance had broken out on the very moment when this singular appearance had been observed.

The next point to be noticed is, that magnetic storms are always accompanied by auroræ and earth-currents. The latter are currents of electricity which traverse the surface of our globe, a portion of which is caught up by the telegraphic wires, thereby often seriously disturbing them in their communications. May not this connexion which subsists between magnetic storms, earth-currents, and auroræ be of the following nature?

Let us, for the purpose of comparison, liken our magnetic earth to the soft iron core of a Ruhmkorff's machine; again, the atmosphere in its lower strata may be compared to the insulator which separates the core from the secondary coil, while, on the other hand, the upper strata of the atmosphere, when these are sufficiently attenuated to conduct electricity, may be likened to the secondary coil itself; also the crust of the earth, being permeated with moisture, becomes a conductor, and may likewise be compared to the secondary coil. Whenever, therefore, we have a sudden change of the earth's magnetism in one direction, we should have in the upper strata of the atmosphere and in the crust of the earth currents of one kind; and when we have a sudden change of magnetism in the opposite direction, we should have similar currents of an opposite description. It need hardly be remarked that those currents which take place in the upper strata of the atmosphere will form auroræ, while those in the crust of the earth will constitute earth-currents. It was then shown that an explanation of this nature agreed best with the form of the Kew disturbance-curves, taken in connexion with the simultaneous earth-currents recorded by Mr. C. V. Walker, while all the observed phenomena are decidedly against the idea that earth-cur-

rents cause magnetic disturbances in the same way that a current acts directly upon a magnet. Now, if the sun be able to create a terrestrial aurora, why may he not also create auroræ in his own atmosphere? There are some grounds for supposing that the red flames, which become visible during total eclipses, are veritable solar auroræ. The argument in favour of this hypothesis is, in the first place, that the red flames have very high actinic power, and in this respect are similar to terrestrial auroræ; and in the next place that, since they sometimes extend to the enormous distance of 70,000 miles above the sun's photosphere, we are naturally induced to associate them with those phenomena which require the smallest possible amount of atmosphere for their manifestation; and the experiments of Mr. Gassiot prove that electrical discharges, similar to the aurora, are preeminent for the very small amount of atmosphere which they require. One other point remains to be noticed; and this is, that there appear to be two separate magnetic disturbing forces, both connected with the sun, which act simultaneously upon the magnet, the position which the latter assumes being due to the combined effect of both. In conclusion, it may be stated that the attention of foreign men of science has of late been much directed to the problem of terrestrial magnetism; and five sets of magnetographs, similar to those in operation at the Kew Observatory, have already been procured by foreign governments. These, however, will be placed in the northern hemisphere; and it is to be desired that some of our colonies in the southern hemisphere may come forward in order that, by the next epoch of maximum disturbance (1869), there may be such a network of magnetic observatories as may enable us to obtain the solution of this important problem.—*Proceed. Royal Inst.* vol. iv. part 1 (No. 37), p. 55.—See *Phil. Trans.* for 1862 (vol. clii.) p. 621.

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14. *Weather-prognostics.*—"*In all cases* the weather of the *vernal equinoctial week, from the* 18*th to the* 25*th March inclusive*, seemed cut off and separated, in meteorological character, to a remarkable degree from that of the period immediately preceding or following it—thus commending itself to the attention as a very remarkable portion of the year.... The weather of that period, narrowly observed, was so strikingly copied and reproduced during some summers, and so failed apparently in being reproduced in others, ... when it appeared that it was in the *extraordinary and strongly marked equinoxes and summers* that the resemblance of weather and atmospheric movements could be traced, and in the *moderate ordinary equinoxes and summers* that it could not. Here therefore comes out a useful rule:—*An ordinary equinox is followed by an ordinary summer, and predicts it; an extraordinary equinox predicts and is followed by an extraordinary summer, and one like it in character*; and all that is *necessary to judge reasonably* of the future summer in the different localities is to have a *previous sufficient experience of what an ordinary equinox in such locality is like*.... It will be found that the 18th of March generally in-

augurates a new weather-era, which, with continual changes, extends to the 25th."—*From 'The Summer of* 1862,' by THOS. DU BOULAY (April 1862).

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15. *The Summer of* 1863.—"The Summer comprises May, June, July, August, and September (not April). It is not considered probable that either heat or cold, or drought or moisture, will anywhere at any time so predominate as to interfere with a great final return from the cereal or even leguminous crops, though there must ever be small but decided local differences of climate. Not only may it be expected that wheat may yield a superlative return in quantity and quality, but that the spring crops also, including barley, oats, beans, peas, and potatoes may also be thoroughly good..... There seems no reason why the early crop of hay should not be good also, though it is quite possible that the latter pastures may be rather bare from dryness and heat.... It may be expected that the crops throughout England, Scotland, and Ireland will be safely housed in excellent condition before the arrival of the autumnal rains."—THOS. DU BOULAY (April 1863).

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16. *Simple Formula for calculating Heights barometrically.*—"As the British Highlands do not exceed 5000 feet in altitude, and lie near the parallel of 56° north latitude, ... the following simple rule will .... suffice for calculating all British heights:—

"Multiply the difference of the barometers by 524, and divide the produce by the sum of the barometers, retaining three decimal places. Multiply this quotient by the sum of the temperatures of the air increased by 836, and divide the product by 9, keeping one decimal place. For aneroid and corrected mercurial barometers, the quotient is the height in English feet. For uncorrected barometers, subtract $2\frac{1}{2}$ times the difference of the temperatures of the mercury.

"Ex. 3. Height of Ben Lomond (see Col. Sir H. James's Instructions for taking Meteorological Observations, App.):—

A 59·0	B 29·890 in.	M 60·8
a 47·8	b 26·655	m 49·3
836·0	B+b 56·545	M−m 11·5
942·8	B−b 3·234	×$2\frac{1}{2}$
		28·7

$$3{\cdot}234 \times 524 \div 56{\cdot}545 \times 942{\cdot}8 \div 9 - 28{\cdot}7 = 3110{\cdot}5 = h - \mathrm{H}.$$

"The height by Laplace's formula is 3110·8; by levelling, 3115·8. The accuracy of the present formula is only intended to be tested by Laplace's, and it will be wrong to at least the same extent."—ALEX. J. ELLIS, *Proceed. R. Soc.* vol. xii. p. 513, March 26, 1863.

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17. *Nadar's Balloon-Descent.*—"Then began a furious disordered race; all disappeared before us—trees, thickets, walls, all broken or burst through by the shock; it was frightful. Some-

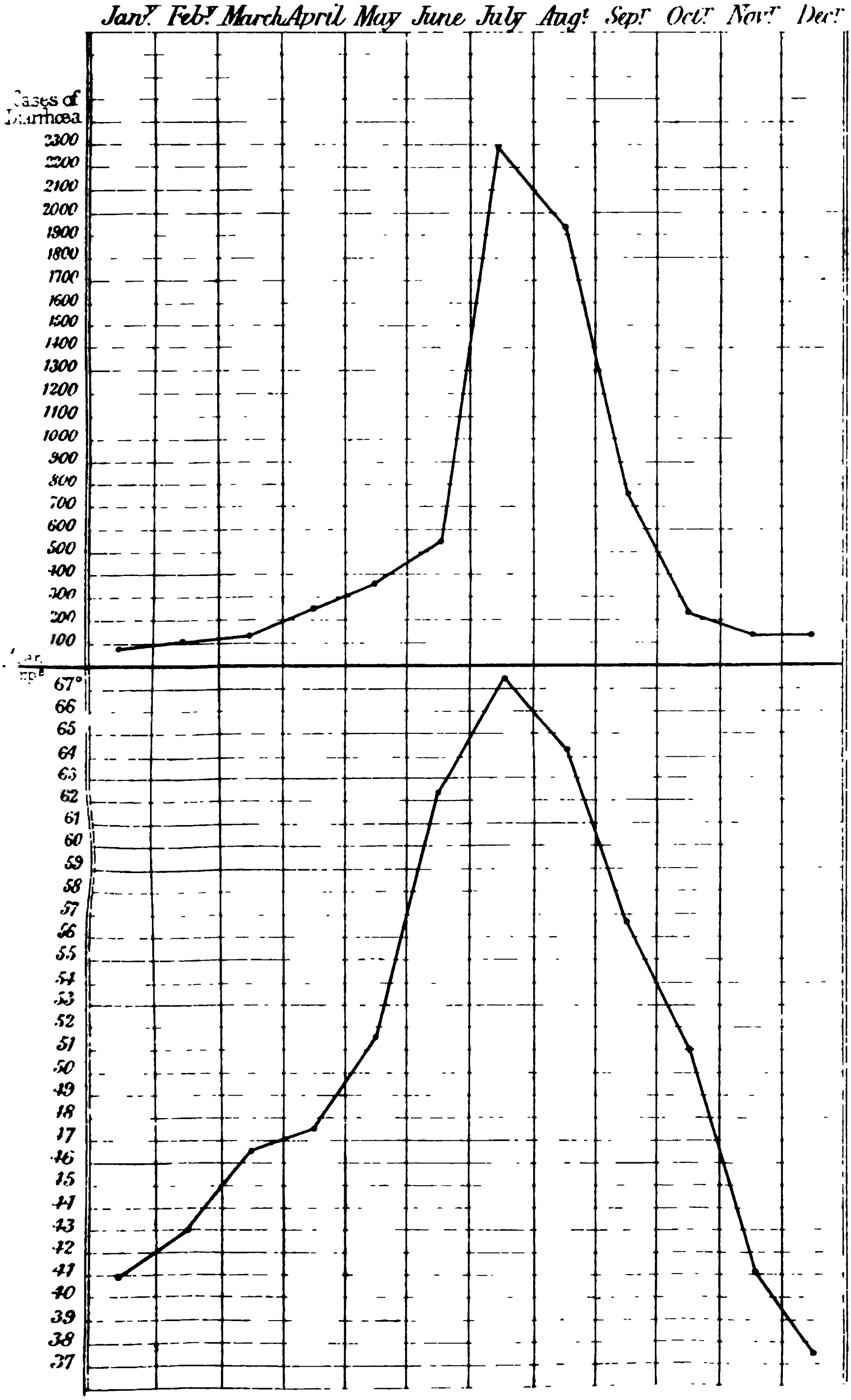
times it was a lake, in which we plunged; a bog, the thick mud of which entered our mouths and our eyes. It was maddening. 'Stop! stop!' we shouted, enraged with the monster who was dragging us along. A railway was before us—a train passing; it stopped at our cries, but we carried away the telegraphic post and wire. An instant afterwards we perceived in the distance a red house: I see it now. The wind bore us straight for this house. It was death for all, for we should be dashed to pieces. No one spoke. Strange to say, of those nine persons, one of whom was a lady, who were clinging to a slender screen of osier, for whom every second seemed counted—not one had any fear. All tongues were mute, all faces were calm. Nadar held his wife, covering her with his body. Poor woman! Every shock seemed to break her to pieces.

"Jules Godard then tried and accomplished an act of sublime heroism. He clambered up into the netting, the shocks of which were so terrible that three times he fell on my head. At length he reached the cord of the valve, opened it; and the gas having a way of escape, the monster ceased to rise, but it still shot along in a horizontal line with prodigious rapidity. There were we squatting down upon the frail osier car. 'Take care!' we cried, when a tree was in the way; we turned from it and the tree was broken; but the balloon was discharging its gas, and if the immense plain we were crossing had yet a few leagues we were saved. But suddenly a forest appeared in the horizon; we must leap out at whatever risk, for the car would be dashed to pieces at the first collision with those trees. I got down into the car, and raising myself I knew not how—for I suffered from a wound in my knees—my trousers were torn: I jumped, and made I know not how many revolutions, and fell upon my head. After a minute's dizziness, I rose. The car was then far off. By the aid of a stick I dragged myself to the forest, and having gone a few steps I heard some groans. Saint Félix was stretched on the soil, frightfully disfigured; his body was one wound. He had an arm broken, the chest torn, and an ankle dislocated. The car had disappeared. After crossing a river, I heard a cry. Nadar was stretched on the ground with a dislocated thigh; his wife had fallen into the river. Another companion was shattered. We occupied ourselves with St. Félix and Nadar and his wife. In trying to assist the latter, I was nearly drowned; for I fell into the water and sank. They picked me up again, and I found the bath had done me good. By the assistance of the inhabitants, the salvage was got together. Vehicles were brought; they placed us upon straw. My knees bled, my loins and head seemed to be like mince-meat; but I did not lose my presence of mind an instant, and for a second I felt humiliated at looking from the truss of straw at those clouds which in the night I had had under my feet. It was in this way we reached Ruthem, in Hanover.

"In seventeen hours we had made nearly 250 leagues. Our *course infernale* had covered a space of three leagues.'"—*Daily Telegraph*, Oct. 24, 1863.

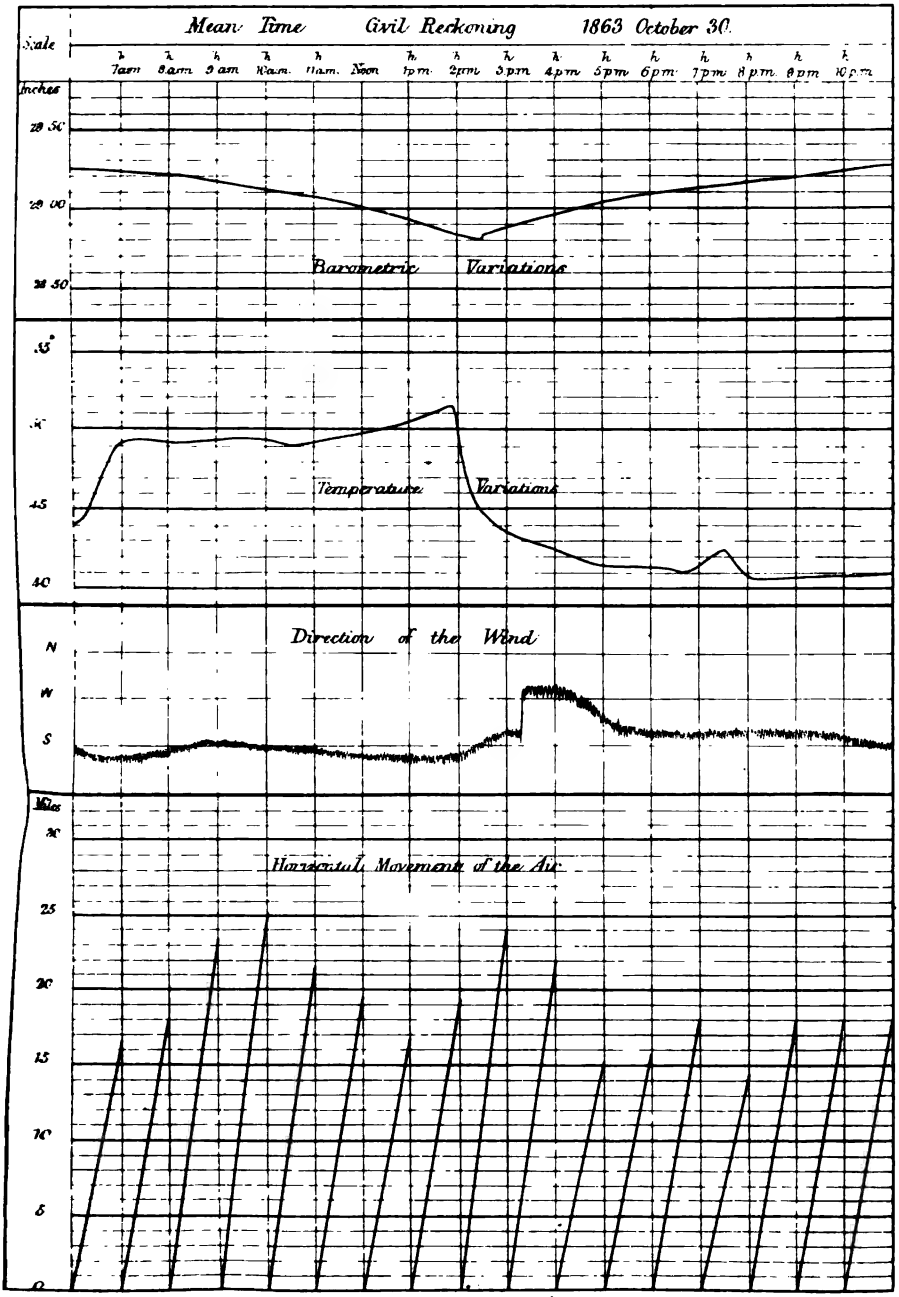
Plate XVII.

1859.



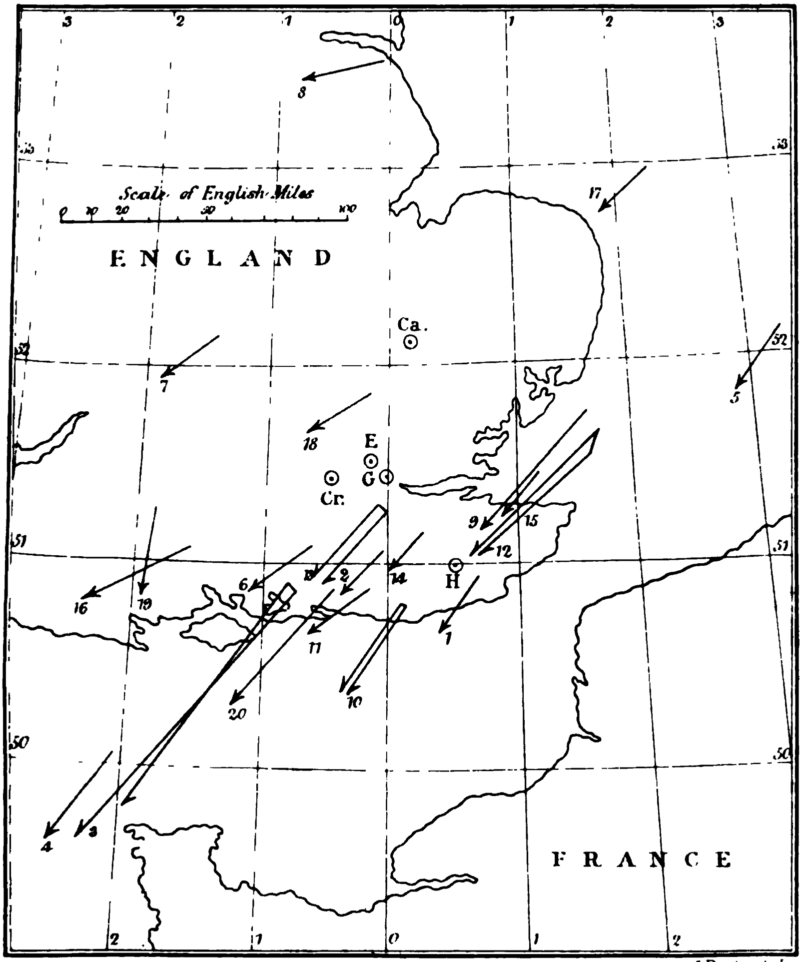
J Basire

Diagram exhibiting Meteorological Phenomena on 1863. October. 30. as indicated by self-registering Instruments at the Radcliffe Observatory, Oxford.



J. Basire lith.

CHART OF 20 METEORS DOUBLY OBSERVED,
AT HAWKHURST AND ELSEWHERE.
9H–11H P.M. AUG. 10TH 1863.



Ca. *Cambridge Obsy.*
Cr. *Cranford Obsy.*
E. *Euston Road Obsy.*
G. *Greenwich Observy.*
H. *Hawkhurst.*

Meteors 3, 10, 12, and 13 received duplicate determinations

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

VOL. II.] 1864, JANUARY 20. [No. 10.

R. DUNDAS THOMSON, Esq., M.D., F.R.S. L. & E.,
President, in the Chair.

Edward Hirst Hudson, Esq., of Moorville Otley, Yorkshire; and
Charles Ferdinand de Kierzkowski, Esq., 24 Great George Street, S.W.;
were balloted for and duly elected Members of the Society.

The names of Nine Candidates for admission into the Society were read, and ordered to be suspended.

The following gentlemen, who had been duly elected Members, having subscribed the Form No. 2, and having paid their first Annual Contribution, were admitted into the Society:—

	Elected
Alex. Jno. Cuming, Esq., A.K.C.	1863, June 17.
F. Pratt, Esq.	1863, March 18.

XLVIII. *Vapour-pressure and Vapour-action.*

By JOHN C. BLOXAM, Esq.

INVESTIGATIONS and suggestions, which have been made within the knowledge of our Society by several independent persons, lead to views on the action of the vapour existent in the atmosphere which are somewhat at variance with those that have been promulgated as orthodox; and it may be worth the while to consider

what the new evidence amounts to, and what it leads to. In the first place, I may refer to some limited (too limited to have much weight alone) experiments of my own, made throughout the year 1856; which consisted of simultaneous observations carried on at two sites, differing from one another in elevation, and considerably less than a mile apart. The lower station was in Newport, where I was myself the observer: the upper station was at Staplers, where a friend (Mr. Clarke), who I believe was punctual and accurate, observed. The upper station was 180 feet above the lower: its neighbourhood is almost devoid both of trees and of open water; it has a dry gravelly soil, and is nearly on the summit of a hill; Newport has a clay soil, is surrounded with hills, and has a mill-stream running near to the site of observation. The mean dew-point temperature was found to be 0°·4* lower at Newport than at Staplers, at the hour 9 A.M.; and the humidity was 5 lower, the atmospheric temperature at 9 A.M. having been 1°·6 higher, although the *minimum* temperature was 0°·5 lower. The dew-point values for the months June, July, and August give a mean difference of −1°·6 for Newport, and those for the months March, April, May, October, and November give the difference +0°·2. Under the influence of sunshine this defect was augmented to 2°, and the excess to 0°·4. These results are connected with one particular hour in the day; and no doubt the statement would stand very differently for other hours, but this does not affect the use now intended to be made of them†. Mr. Glaisher found in his balloon experiments that a higher dew-point frequently obtained at a greater elevation than at a lower. Professor Lamont has proved by his experiments that air and vapour may be introduced and retained in a closed vessel for a considerable period of time, without more than very imperfect intermixture of the two taking place,—the air and the vapour being in his experiments each maintained in a state of quiescence‡. Aqueous vapour, Professor Airy tells us, combined with air will not rapidly disseminate itself; "it will long remain in one place, as if the mixture of air and vapour produced viscosity." Possibly this viscosity, if it be peculiar to aqueous vapour, may depend upon electric control, and the electric condition may sometimes

* If correction should be made for the greater activity of evaporation from the wet bulb of the thermometer at the higher level, this will augment the calculated difference.

† Most of these particulars are stated in 'Meteorology of Newport,' p. 138.

‡ Dalton, it is to be observed, had previously taught that evaporation of water goes on very slowly in space filled with air in a state of quiescence.

check and sometimes favour the dissemination—at least in atmospheric action. Professor Lamont says that he showed, in the year 1857, "by means of observations extending through many years, that in a small vapour-pressure the mean reading of the barometer stands quite as high as in a great vapour-pressure." My own observations, which extend through sixteen years, fully confirm this statement; but I believe the doctrine commonly taught is, that much vapour tends to cause the barometer to stand low, and *vice versâ*. I have shown that the more vapour there is in the atmosphere, the less is there of air, and *vice versâ*; so that air and vapour—comparing *seasons* of much vapour with *seasons* of little vapour—are alternative ingredients, excess in one just supplementing defect in the other; and the barometer thus stands pretty much at the same height at the two respective seasons of great and of little vapour-pressure*. But this does not appear to indicate any law as to how or where the vapour is disseminated, or aggregated, or manifested; it only indicates a law as to the relative proportions of these two atmospheric constituents. I assume that the Professor's calculations, as well as my own, take account of that portion of the vapour only which *is* disseminated, and, consequently, detected by the hygrometer. The barometer reaches its highest reading, at Newport, viz. 30·143 in. (reduced), on September 3; and of this pressure ·374 in. is contributed by vapour. The next highest reading, viz. 30·125 in., occurs on March 8; and of this ·199 in. is contributed by vapour. The highest value for vapour-pressure, viz. ·418 in., occurs on July 31 and three following days; and on July 31 the atmospheric pressure is 29·964 in. The lowest value for vapour-pressure, viz. ·194 in., occurs on February 13; and on this day the atmospheric pressure is 29·996 in. This statement is probably good for comparison; but I do not mean to deny that in every case there may have been much vapour in the upper strata of the atmosphere, which did not affect the reading of the hygrometer, though it did affect that of the barometer, and that, consequently, what was in fact the pressure of vapour transmitted through the atmosphere was recorded as air-pressure: neither is it to be denied that the average value for humidity which would have been obtained by meaning the several values belonging to the several varying strata in the entire vertical column of atmosphere may possibly have been somewhat lower than was indicated through observation at the base of the column,—though there is not much apparent room for error in this respect,

* See 'Meteorology of Newport,' p. 83.

inasmuch as averages computed on a very extended range of observations have been used in the discussion: such averages are not likely to be appreciably erroneous, even if the separate values were so individually. The statement, so far as it serves for the present purpose, shows that the compensating action is very perfect; and it is impossible to say, from the evidence, that much vapour in the atmosphere has the effect either of augmenting or diminishing the compound pressure. It may be observed that the correctness of the barometer indication is not open to doubt; and there is little room for questioning the accuracy of the *dates* assigned for the *maximum* and *minimum* of vapour-pressure, inasmuch as the dates for the maximum and minimum of atmospheric temperature are respectively August 3, 4, and February 11*.

The foregoing evidence seems clearly to establish the fact that vapour and air not only may, but habitually do maintain for some considerable period of time separate positions, as well as independent actions. So far as I comprehend, it would be an egregious error to assume that Dalton's law, as English meteorologists understand it, is false, nevertheless. It is not to be supposed, at any rate, that vapour ever exists in the atmosphere unmixed with air, nor that air ever exists (at least within six or seven miles of the earth) unmixed with vapour. One mass of atmosphere may hold a larger proportion of vapour than another, whether the one be above, below, or aside of the other; and this being so, the quantity of vapour that is shown by the hygrometer to obtain at one level is not a safe criterion of the quantity that may obtain at any other level.

It is more easy now, perhaps, to understand how it is that rain frequently falls when the humidity of the atmosphere we experiment on is at a comparatively low value, and it is not uncommon to have rain and sleet in March and April with the humidity at a *decidedly* low point,—also how it is that we find the atmosphere at saturation-point when the tendencies are utterly opposed to rain. In the former case, a stratum of saturated air is sustained by the lower dry stratum, and of course the upper (whether it consist of air or of vapour) contributes by its weight to the pressure of the lower stratum, as does also the whole of the column above *it*. If the vapour of the upper humid stratum disseminate itself through the lower stratum, the dew-point would then rise in the lower stratum, although the tendency to rain would be lessened by the humidity

* The values and dates referred to on pp. 43, 44, and 47, are taken from the smoothed curves given in 'Meteorology of Newport.'

being reduced in the *humid* mass: the barometer during this interchange would remain unaltered. If the vapour does not thus disseminate itself, but remains isolated (we may disregard the air that may be mixed with this vapour, because the air that is present has nothing to do with the so-called *saturated* condition, nor with the results this saturation leads to), it may be subjected to decrement of temperature in various ways; and then rain will fall, although the temperature should remain higher than that which obtains near the earth. The necessary decrement of temperature may ensue, through the mass moving to a region of lower temperature, which, as a prevailing rule, it does by progressing to higher latitudes; but the lower temperature is frequently met with by the exchange of a land for a sea surface whilst temperature is rising, and of sea for land when temperature is declining; or it may ensue through a cold air proceeding to *it*; or through the mass rising, in consequence of its relatively high temperature or of its own disseminating tendency, to a higher level; or, fourthly, as has been experienced in the balloon ascent, through the sun's rays being intercepted by a higher range of clouds. The first-named cause of decrement is probably very frequently brought about by deposition occurring in a higher latitude or other colder region, the void thus arising in the atmospheric mass taking off atmospheric weight and pressure, and putting the atmosphere in motion to occupy the void. Since the vapour carries the air along with it to the site of deposition, accumulation of air must needs be going on whilst the atmosphere is losing its vapour; and by the time the humid mass has been drained of its excess of vapour, and deposition consequently declines, and the atmosphere stagnates, the barometer will indicate great atmospheric pressure, not because there is *little* vapour, but because there is *much* air. Moreover the accumulation of atmosphere that takes place towards the higher latitudes will necessarily entail a reaction; the vapour that flows to the site is lost there, but the air which accompanies it is not lost; this ingredient shifts from one spot to another, but does not lose its gaseous form; as soon as the cause of accumulation ceases, the atmosphere will flow back again to the lower latitudes; in other words, a north wind will be experienced in our latitudes,—the high pressure thus bringing the north wind, rather than the north wind causing high pressure. In the second case of extreme humidity occurring near the surface of the earth during settled fine weather, the phenomenon is generally experienced early in the day, before the sun's rays have power to warm the atmospheric

vapour at a moderate distance from the surface, or before they have had time to warm or to establish the necessary electric conditions, or before the vapour has had time to disseminate itself by its own inherent properties,—in low situations, with a high barometer, the atmospheric pressure impeding the dissemination of the vapour, and in a quiescent air, which favours the stationary attitude of the vapour, as it does that of dry sand.

The suggested movement of the atmosphere to high latitudes, as a consequence of deposition in the higher latitudes, and the subsequent reflux of the atmosphere to low latitudes, as a consequence of accumulation of air and excessive atmospheric pressure in the high latitudes, seem perhaps to suffice for the causation of cyclonic action. When active deposition continues for any considerable time in a high latitude, the consequent reflux is not likely to occur in the same line as the original flow: it *cannot* do so whilst the flow continues; it will pass either to the eastward or to the westward of this line, and, as the reflux is in the direction from pole to equator, it will most probably pass on the west side. There will thus be a circuit formed by two currents running in opposite directions—at first perhaps in close proximity, side by side—the south-tending, heavy, refluent current falling in at the rear of the north-tending light current. The complete circuit being formed and the atmosphere being in rapid motion, the direction of the movement will tend more and more to the true circular form. So long as the deposition continues with unabated energy, the rapidity of motion will increase; but, as the air-constituent is none of it lost, it will increase in quantity, both absolutely and relatively; it will replace the vapour-constituent, the atmosphere will thus become dryer, the barometer will simultaneously rise in consequence of the increase of air, the deposition will subside owing to the decrement of vapour, and the storm will then cease.

I feel confident that no great progress will be made in comprehending the movements of the atmosphere until more consideration is given to the control which the vapour constituent exercises over those movements. If the atmosphere were, in the first place, at rest, and then the vapour constituent were condensed in some one locality, it is as evident that the vapour would be put in motion as that water in a pond would be put in motion by draining away a portion or by a portion being evaporated at any one point; and if, whilst waste is going on energetically at one point, supply is kept up with equal energy at another point, it seems evident that the motion must be liable to become very rapid. Evidence

has been advanced showing that air and vapour are vicarious ingredients in the atmosphere—this being necessary for the maintenance of the equipoise of the whole atmospheric mass; but although there is this opposition in action, there is unity of action also. Vapour, which, in point of fact, is always disseminated through the air, cannot move without carrying the air with it, any more than a bush can be dragged through water without carrying the water with it. It is the vapour, as I think, that mainly controls the movement of the atmosphere; and it is temperature that mainly determines the abundance of vapour, and controls its movement; the dew-point temperature and the atmospheric temperature rise and fall together with considerable constancy. The vicarious action is slow—the law is manifested, not in the daily movements, but in those of the seasons; whilst the joint action is brought into play with every shower of rain. The two hemispheres constitute the respective sites of the two vicarious actions, whilst the joint actions occur wherever there is any great disparity of temperature. The vapour exists in large and in small quantity alternately in the two hemispheres; and when there is much vapour, there is little air, and *vice versâ*. The joint action is exemplified at the date of minimum atmospheric pressure; this pressure falls from the maximum on September 3 to the minimum on October 4, in the Isle of Wight. This low reading of the barometer is the result of a great outflow of air; and this outflow of air, it is submitted, is consequent upon a great outflow of vapour: but the influx of vapour keeps pace (nearly) with the outflow. The amount of vapour *at the site* is determined by the temperature at the site: the mean value for temperature does not occur till October 20, and the mean value for dew-point does not occur till October 31; and on October 4 the vapour-pressure is only 0·06 in. above the mean value, whilst the air-pressure is 0·21 in. *below* its mean value. Now the air, which on October 4 has left the site of observation, must have flowed to and exist at some other site; is it not a fair assumption that the site of accumulation is some high latitude or some inland district where, at this period of the year, decrement of temperature would be great, and condensation of vapour very great? And does not this account for the gales of wind that occur in the Channel at this period of the year? This action is a local action depending on local conditions; but as the season advances, the vapour progressively diminishes in quantity, and the air progressively increases in quantity; and this action, it is submitted, is general and belongs to a large portion of the hemisphere.

XLIX. *Remarks on the Storms of* 1863, *December* 2 *and* 3.

By James Glaisher, Esq., F.R.S., Secretary.

The gales which occurred on the 2nd and 3rd of December, 1863, were in many respects more remarkable than that of October 30th. It may be remembered that the chief severity of the October gale lasted for a comparatively short space of time, accompanying the greatest depression of the barometric column, and moderating rapidly with increasing readings of the barometer; and whilst the same characteristics were strongly displayed during the first of the December gales, on the 2nd, yet during the second gale, which followed on the morning of the 3rd, dissimilar and interesting characteristics were recorded. Thus, in this gale, the greatest pressure occurred at the same time as the minimum reading of the barometer (as in the previous gales); yet even after the readings of the barometer had turned to increase, and were increasing with remarkable rapidity, the gale still prevailed with unabated force for some hours—thus differing entirely from that of the previous dayand also that of Oct. 30. The several pressures and directions of the wind during these gales have already been detailed in a short notice appended to the account of the storm of Oct. 30 (Proc. Met. Soc. No. 9, p. 15), but I have deemed it necessary to reproduce them here in connexion with observations made at the Radcliffe Observatory, Oxford. They are briefly contained in the following Tables:—

Table I. Showing the bi-horary directions of the Wind at Oxford and Greenwich, and the bi-horary velocity at Oxford and daily velocities at Oxford and Greenwich, from 1863, Dec. $1^d\,22^h$ to $3^d\,0^h$.

1863. Month, Day, and Hour.	Direction of the Wind.		Velocity of the Wind.		
			Bi-horary.	Daily.	
	Oxford.	Greenwich.	Oxford.	Oxford.	Greenwich.
d h			miles.	miles.	miles.
Dec. 1 22	S. by W.	S. by W.			
2 0	S.W.	S.S.W.	26	486	490
2	W.N.W.	W.S.W.	41		
4	W.S.W.	W.N.W.	48		
6	S.W.	W.	48		
8	S.W.	W.S.W.	32		
10	S.S.W.	S.W.	23		
12	S.E.	S.S.W.	20		
14	S.S.E.	S.	20		
16	S.E.	S.S.E.	36		
18	S.S.E.	S.S.E.	55		
20	S.W.	S.W.	65		
2 22	W.S.W.	W.	72		
3 0	....	W.S.W.	90		

At Greenwich, for the following 24 hours ending $3^d\,22^h$, the velocity amounted to 605 miles.

TABLE II. Showing respective directions of the Wind, with details of pressure, as recorded at the Royal Observatory, Greenwich, during the Gales of December 2nd and 3rd, 1863.

1863. from	to	Direction of the Wind.	Details of Pressure.
d h	d h		
Dec. 1 12	1 14	S.S.W.	From ½ lb. to 3 lbs.
1 14	1 20	S.S.E.	From 1½ lbs. to 6 lbs.
1 20	2 0	S. and S.S.W.	No pressure.
2 0	2 2	S.S.W. and S.W.	No pressure.
2 2	2 2½	W.S.W. and W.	No pressure.
2 2½	2 3½	W.N.W. and N.W.	From 6 lbs. to 22½ lbs.
2 3½	2 8	W.N.W.; W. and W.S.W.	From 1 lb. to 7 lbs.
2 8	2 16½	W.S.W.; S.W.; S.S.W. and S.S.E.	No pressure.
2 16½	2 20	S. and S.W.	From 1 lb. to 9 lbs.
2 20	2 21	S.W. and W.	From 5 lbs. to 21 lbs.
2 21	3 8	W. generally	From 3 lbs. to 15½ lbs.
3 8	3 13	N.W. and W.N.W.	From 1 lb. to 7 lbs.
3 13	3 16	W.	From ½ lb. to 1 lb
3 16	4 0	W.S.W.	No pressure.

The preceding Table fully details the varying pressures of the wind during these gales, and shows that two great pressures were recorded, each exceeding 20 lbs. on the square foot. At the times of these extreme pressures the direction of the wind was changed to the amount of about 45° in direct motion; and declines of temperature occurred, in the former case to the amount of 5°, and in the latter to about 9°. The minimum values of the barometer also occurred at or near these extreme gusts; indeed the extreme severity of a gale may invariably be expected at the time of the minimum reading of the barometer.

The rapid changes in the readings of the barometer during these gales were especially curious and interesting. Commencing with a maximum value of 29·40 in. at midnight on the 1st, the readings decreased rapidly to 28·81 in. by 11^{h} A.M. on the 2nd, increased to 29·38 in. by 9^{h} 30^{m} P.M., remained at this reading till 11^{h} P.M., then turned to decrease rapidly, reaching the minimum value of 28·79 in. at 7^{h} 30^{m} A.M. on the 3rd, remained this reading for 42^{m}, then turned to increase with great rapidity, reaching 30·22 in. by noon on the 4th. It will thus be seen that in 28 hours the readings increased by the extraordinary amount of 1·43 in., whilst during 6 hours on the 3rd the rate of increase was almost uniformly 0·08 in. per hour.

The following Table contains hourly readings at Oxford and Greenwich during this interesting period.

TABLE III. Showing comparative readings of the Barometer at Oxford and Greenwich, from 1863, December 1[d] 22[h] to December 3[d] 22[h].

1863. Month, Day, and Hour.	Barometer Readings. Oxford.	Barometer Readings. Greenwich.	1863. Month, Day, and Hour.	Barometer Readings. Oxford.	Barometer Readings. Greenwich.
d h	in.	in.	d h	in.	in.
Dec. 1 22	28·77	28·82	Dec. 2 21	28·89	28·90
1 23	·78	·81	22	28·97	28·97
2 0	·81	·84	23	29·04	29·03
1	·84	·84	3 0	·09	·09
2	28·95	·87	1	·13	·14
3	29·04	28·95	2	·17	·18
4	·10	29·06	3	·23	·23
5	·18	·14	4	·29	·27
6	·24	·23	5	·37	·33
7	·26	·27	6	·44	·40
8	·28	·30	7	·53	·48
9	·31	·34	8	·62	·57
9½	·31	·38	9	·70	·66
10	·31	·38	10	·76	·73
11	·30	·38	11	·84	·80
11½	·28	·37	12	·89	·84
12	·27	·36	13	·94	·89
13	·24	·35	14	29·98	·92
14	·19	·32	15	30·01	29·96
15	29·04	·28	16	·04	30·01
16	28·93	·14	17	·07	·05
17	·80	29·06	18	·11	·09
18	·73	28·92	19	·12	·13
18¾	·68	·85	20	·14	·15
19	·74	·83	21	·16	·18
2 20	28·80	28·79	3 22	30·18	30·20

d h — d h
Dec. 1 22 minimum reading at Oxford; 1 23 minimum at Greenwich.

d h m — h m
Dec. 2 8 40 to 10 40 stationary at maximum value at Oxford.
2 9 30 to 11 20 stationary at maximum value at Greenwich.
2 18 30 to 18 45 minimum value at Oxford.
2 19 30 to 20 12 minimum value at Greenwich.

L. *On the Velocity of Propagation, between Oxford and Kew, of Atmospheric Disturbances.* By BALFOUR STEWART, Esq., M.A., F.R.S.

Kew Observatory, January 12th, 1864.

THE squall of 30th of October last has already been brought before this Society. On the afternoon of this day the Kew barograph records a very sudden fall in the atmospheric pressure, which seems to have reached its lowest point about $3^h\ 9^m$ P.M., G. M. T. At this instant the gaslights in the room which contained the barograph went out, owing it is supposed to a very violent gust of wind. These were again relit in a quarter of an hour; in the interval, however, the barometer had risen considerably; and indeed the curve, even though incomplete, presents the appearance of a very rapid rise. Perhaps we may suppose that a very sudden increase of pressure accompanied the gust of wind at the moment when the gas went out, in which case the turning-point of the barograph-curve would be at $3^h\ 9^m$ P.M. Through the kindness of the Rev. R. Main, of the Radcliffe Observatory, Oxford, I have been favoured with a copy of his barograph-curve, from which it appears that the pressure of the air began to increase very rapidly at about $2^h\ 30^m$ P.M.

On this occasion, therefore, Oxford was *at least* 39^m before Kew.

On November 21st there was a similar squall; and it appears by the Kew barograph that the atmospheric pressure took a very sudden upward start at $4^h\ 45^m$ P.M., while at Oxford this took place at 4 o'clock.

Oxford, on this occasion, was therefore 45^m before Kew.

The 3rd of December last was likewise a very stormy day, and during this storm the barograph at Oxford and Kew present at least two points of unmistakeable correspondence. The one of these occurred at Kew at $3^h\ 35^m$ A.M., and at Oxford at $2^h\ 40^m$ A.M., the difference being 55^m.

The other of these occurred at Kew at $7^h\ 40^m$ A.M., and at Oxford at $6^h\ 50^m$ A.M., the difference being here 50^m.

We have thus for—

October 30th, a difference between Kew and Oxford of.. 39^m
November 21st, a difference between Kew and Oxford of 45^m
December 3rd, a difference between Kew and Oxford of $\begin{cases} 55^m \\ 50^m \end{cases}$

Oxford being always before Kew.

The first of these numbers is, however, subject to a slight uncertainty, from the cause already mentioned.

LI. *Earthquake-Theory*. By Charles Griffin, Esq. Communicated by Charles V. Walker, Esq., Secretary.

(Extracts.)

On the 6th of October I lay awake from 3 till 4 o'clock. I was lying at full length on my right side, with my head to the south. Not far from that side of my house run both the London and North Western and the Great Western Railways. I felt myself suddenly rolled as it were towards the east, and at once thought it might be from an earthquake. However, I heard a train moving, which shortly passed; but I found no rolling motion of my body, though the trains often shake my windows.

I heard, next day, that some of my neighbours had felt the motion.

I believe it is now pretty generally admitted that the earth is a molten globe of metals and earths, surrounded on all sides by a cool crust, on which we live. I do not know what thickness that crust may have; but soundings show the sea to be in some places about six miles deep; and I have read of a chasm in Sweden or Norway little less than ten miles deep. The general stability of the earth's crust would, I think, lead one to suppose that the average thickness must be some scores of miles.

Judging by what we know of the outer surface of the crust of the earth, I think we may be justified in concluding that the internal ball or yelk of melted matters, being in contact with the inner surface of the crust or shell, will, where that surface is most liable to fusion and disintegration, lessen the thickness of the crust there, and tend to approach nearer to the upper surface.

Thus would be produced a cavernous state of the under surface of the crust; and such concavities or caverns would be liable to become the receptacles of gases and vapours, derived from the disintegrated materials or otherwise, but in an enormously compressed state, separating the molten matter from and supporting the hardened crust.

The roof of the concavities might continue to fall into the molten pool beneath, and the gases or vapours would probably press down the surface of the molten matters below their ordinary or general level. By these means I suppose the earthy crust to become so thin, ultimately, as to give way suddenly, liberating the compressed gases and steam.

The result would be a sudden rising of the depressed liquid and

descent of the solid crust, which would sometimes probably come together like the clapping of hands.

It is very probable that these ruptures of the crust take place often at sea. If the rupture were beneath a sea a mile only deep, where the pressure on the imprisoned gases or vapours would be, from the weight of the water alone, more than a ton to the square inch, we need not wonder if the relief from, or removal of, even such a comparatively small pressure should be propagated through a concavity or concavities scores, nay, hundreds of miles in extent almost in an instant, and that more especially if steam escapes and becomes suddenly condensed while escaping.

These views seem to agree with the fact of the general thump a ship's bottom receives at sea from an earthquake. In our own earthquake, a ship received such a thump twenty miles from Milford Haven.

That the rupture should be often at sea would seem to arise from three causes: first, the yielding nature of water as compared with earth; second, the bottom of the sea being certainly in most cases nearer to the points of weakness in the earthy crust than the surface of the dry land; and third, the mean density of the earth being greater than—about four and a half times—that of water.

The rupture is, of course, certain to take place at the point of least resistance.

Earthquakes generally, if not always, occur near the sea; and, in the case of the recent earthquake, the eastern shores of St. George's Channel and the Irish Sea, where the shocks appear to have been most strongly felt, is an old sore place, where the older geological formations have come to the surface, and have been perforated by veins of melted matters from beneath, and where nearly all the superior strata have been removed.

This is just the coast where we might expect a thin part of the crust of the earth, and inverted cavities beneath that crust, filled with gases. A volcano is probably one of these vents thus opened, whence melted earthy matters (which I will now call lava) are ejected and cooled till the mountain is formed. This seems all but proved by the action of Vesuvius. While smoke or vapour arises, the lava, I presume, remains at its ordinary elevation, and supports the mountainous walls of this chimney of nature in exact equilibrium.

When the vapours cease to appear, *the natives foresee an eruption.* By disintegration and falling-in of the mountain, the orifice is

closed—the falling materials becoming not melted, but caked together like the crust that forms over fires of bituminous coal, and stops their burning and smoking upwards.

The vent for the gases or vapours being thus closed, they accumulate between the newly formed crust or plug and the lava below, pressing and forcing the latter downwards. Loose materials descend on this crust, and assist it to resist any upward pressure.

The crust in time crumbles away below, till it becomes too weak to resist the upward pressure of the imprisoned and increasing gaseous matters (and these pressed upwards by the depressed lava), till the recently formed crust or volcanic plug gives way, and the broken parts and the loose stones accumulated on its top are shot hundreds of yards into the air by the sudden expansion and expulsion of the compressed gases.

The lava, released instantaneously from the downward pressure, rushes back towards the position whence it had been depressed, being pressed from below and all round by the general mass of lava.

By these motions an impetus or momentum being acquired by the lava, it is not only forced with great velocity back to its original elevation, but is sometimes impelled upwards to the top of the volcanic crater and over its sides in immense streams.

I think it also probable that, after an expulsion of gases and consequent removal of their pressure upwards, one or more new plugs may become successively formed and broken by new formations of gas, before the lava has had time to acquire such force as to attain the point of the volcanic throat where the plugs are formed.

The appearance of a recently formed volcano in the Mediterranean, and of another in the same neighbourhood some years since, appear to agree with my views.

It seems highly probable that Etna and Vesuvius, and still more probably Stromboli, originally rose in the same way from the sea.

The recent earthquake appears to me, also, to confirm these views of the general origin of earthquakes and volcanoes.

The late earthquake, like many others, showed that there was a nearly simultaneous action throughout the whole region affected; and nothing, I believe, but the cause I have suggested, or electricity, could produce such steady, equable, and innocent effects so rapidly over a distance of more than 200 miles of longitude and nearly as much of latitude.

LII. *History of the Earthquake of* 1863, *October 6th.*

By E. J. Lowe, Esq., F.R.A.S., F.G.S., &c.

The earthquake of October 6th, 1863, was felt throughout Wales and the central counties of England, extending north as far as Doncaster, Huddersfield, and Clitheroe; east to Market Rasen, Peterborough, and Bedford; south to London, Dorchester, and Plymouth; and in the west crossing St. George's Channel to Dublin and Wexford. It was also felt in the few isolated places Lancaster, Ulverston, Harrogate, Malton, Scarborough, Bury St. Edmunds, Brighton, and the Isle of Wight. A line drawn from Stafford to Cardiff would pass through the localities of greatest intensity.

The focus of the shock must have been at a great depth, as it was felt almost simultaneously throughout England and Wales, whilst, had it been near the surface, it would have occupied 8 or 10 minutes in travelling to some of the places. The descrepancies in its estimated direction are probably owing to the vertical predominating over the horizontal movement. Near the centre of concussion, the explosion occurred immediately after the shock; but in more distant places the noise was heard *to precede* the shock, owing to the much more rapid velocity of the *sound-wave* over that of the *earth-wave*. It is now certain that there were several shocks, the two most severe close together at $3^h\ 23^m$ A.M., the less violent ones being felt at $2^h\ 25^m$, $3^h\ 10^m$, and 4^h A.M.

My warmest thanks are due to Mr. Allport for information from every station-master on the Midland Railway. At 81 stations the earthquake was not felt, and at 17 others only slightly; whilst at 107 stations the noise was heard, rumbling in 30 cases, like distant thunder in 23, as a passing train in 21, passing carts in 8, burglars at work in 13. Bells were rung at Chesterfield, Cromford, Leicester, Market Harborough, Finedon, Isham, and Birmingham. The gaslights flickered at Leicester; a clock stopped at Toton; a ceiling cracked at Bleasby Gate; bricks fell at Mansfield; glass was broken at Alfreton; a wall of the reservoir fell, and the water became muddy, at Derby; and the night-man, thinking it was an approaching train, put his signal on at Bromsgrove.

Sixty-four station-masters describe the direction from which the shocks seemed to come: 20 from W. to N.W.; 15 from S. to S.E.; 10 from N.; 9 from N.E.; 6 from S.W.; and 4 from E.

From 251 private sources, the noise was described in 94 instances as rumbling, in 33 like a railway train, in 35 as resembling thunder, in 20 as an explosion, in 11 like wind, and in 38 it

was attributed to burglars. One lady made it appear like a dog's-tail thumping on the floor; but it is only fair to qualify this description, as it seems probable that the weights of a clock struck against the case. In several hundred instances the observers considered that their beds were lifted up from beneath and afterwards moved sideways, showing both the vertical and horizontal movements.

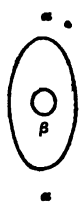
Many observers mention two sounds, the first as if burglars were breaking into the house with but little dexterity, whilst a heavy waggon was passing at the bottom of the lane. At Weston, books fell from the selves; yet none of the police on duty felt anything. On the Yorkshire coast, fishermen felt a false tide; at Penzance, the sea was much agitated; twenty miles from the shore near Milford Haven, the captain of a vessel felt a concussion like striking on a rock. At Branscombe, the ceiling of a room was thrown down; in Liverpool, glass was broken in many houses; at Prestwood and Hardwich, pheasants began to crow; at Taunton, the people ran into the streets; at Malvern, the gas was extinguished; at Monmouth, the church spire was damaged for 30 feet, and many persons rushed out of their houses. At the Deanery of Llandaff, a bed was felt to be lifted up and jumped down, and the pictures on the walls were all moved in the same direction. At Coventry, the Exhall Colliery was filled with water. At Hereford, an extraordinary sound was heard approaching from the west, accompanied by a violent shaking of the earth: the noise was a rapid succession of detonations, not loud in its approach, but in an instant equalling thunder, and then in a moment dying away; with the crash was a fearful lift from beneath, directly upwards; many bells rang, some walls and ceilings were cracked, china and glass broken, and the trees shook violently, although the air was calm. At Stretton Rectory, Mr. Key describes the crash as being equal to the loudest peal of thunder, yet fuller, deeper, and grander. At Hampton House, near Hereford, Mr. Weare, who is an astronomer, was sitting facing the west, when up went the leg of his chair, and he distinctly felt the shock in his right leg before the left was affected; for though almost instantaneous, it was appreciable. The whole lasted three seconds, the roar going off in five seconds more. At the Parkfield Ironworks, near Wolverhampton, none of the miners felt anything, although at the surface it woke every one. At Ross, in Herefordshire, the wife of Dr. Beckett saw the west wall of the house leaning over towards her, and a chair tilted off two legs nearly 4 inches in the same direction. At Sponford Rectory,

Ilchester, the earth cracked across a hard carriage-road. At Merthyr Tydvil, the colliers, who were at a depth of 1200 feet, heard a noise as if a number of empty waggons were being rapidly propelled through the workings. At Hardwick Parsonage, in South Wales, a woman noticed a chair jigging on the floor; and after it had ceased, she distinctly heard a repetition with the chairs in the kitchen below. The greatest violence seems, however, to have been at Garway (12 miles from Ross, and the same distance from Hereford and Abergavenny): here the noise resembled rattling thunder, approaching and passing away again; the south wall of Mr. Herbert's house was split from top to bottom; the wall of all the top rooms cracked, and several bricks fell down a chimney; Mr. Herbert's bed was lifted up perpendicularly at each corner: in his son's house, several walls were cracked, and a ceiling fell.

Perhaps the most amusing account is that of a gentleman at Marwood, who imagined, from the movement, that his head was being filled by a rush of blood; and, as a precaution, he took a blue pill.

Beeston Observatory.—A smart shock of an earthquake was felt here, between 3.20 and 3.30 A.M. of October 6th, many persons being awaken from the shaking of their beds and windows. At the time, the sky was cloudless, the wind west, barometer stationary, and the temperature 31°. The shock evidently awoke me; yet I was unconscious of any movement. I got up and went to take an observation, the time being exactly 3.30 by my watch.

Fig. 1.



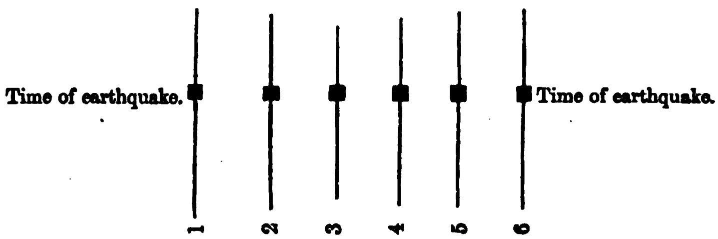
The motion of the earthquake-pendulum at this observatory was from W.N.W. to E.S.E.; and the displacement of chalk, by the 30-foot rod, was ½ an inch, the index-needle moving the chalk so as to leave an *oval*, or rather a *lengthened-oval* hole, where *aa* (fig. 1) shows the form of the hole, and β the size of the index which produced it.

The pendulum is simple in construction, consisting of a wooden rod 30 feet long, freely hung in a tube of 6 inches in diameter, which extends from the summit to the base of my tower. At the base is a heavy brass ball, of the size of an orange, to which a steel index is attached. The index-ball was made in 1850, under my directions, by Messrs. Negretti and Zambra; and its recent performance, after having been idle (except once) for thirteen years, is highly satisfactory. An earthquake, by moving the position of the tower, causes the index to plough up the chalk—the length of

removed chalk registering the displacement of the summit of the tower, as well as the line pointing out the direction of the shock. The form of the hole ploughed up in the chalk seems to prove that we were some distance from the focus of the shock.

There must have been several shocks. Mr. John Fellows, of Beeston Field, is certain that a shock, which woke him, occurred at $2^h\ 35^m$ A.M.; he thought it to be an earthquake, because he saw his watch-chain, which was hanging, swing to and fro. A shock certainly occurred here between $3^h\ 20^m$ and $3^h\ 30^m$, as, at this time, all the zero-pencils on my atmospheric recorder marked the paper in a remarkable manner (fig. 2).

Fig. 2.



1.	Zero-pencil	of	Rain.	These parallel lines advance ½ an inch per hour.
2.	„	„	Evaporator.	
3.	„	„	Thermometer.	
4.	„	„	Wind.	
5.	„	„	Electricity.	
6.	„	„	Barometer.	

Six other zero-pencils similarly marked.

Mrs. Hamilton Gray, of Bolsover Castle, informs me that a correspondent from Madras mentions that the earthquake of October did much damage in Manilla, and was strongly felt in the N.W. Provinces of India.

It is worthy of remark, that the lead of my Observatory at Beeston was cracked in seven places, so as to allow the rain to pass through the roof into the rooms. The cracks were all from W.N.W. to E.S.E., or somewhat nearer W. and E., and each about 6 inches in length.

It may here be mentioned that information from the following places shows that the earthquake was not felt at any of them:—

Newcastle, Allenheads, Shields, Stockton, Northallerton, Kendal, Isle of Man, Settle, Skipton, Bradford, Normanton, Hull, Island of Anglesea, Buxton, Lynn, Hertford, Uckfield, Plymouth, Colchester or Gosfield (in Essex).

On the Midland Railway, starting in the north at Morecombe Bay, the earthquake was not felt between that station and Bradford, except at Keighley, near Leeds. It was felt at Leeds, and then not again till Masbro'; it was felt in all places between Sheffield and Masbro', but in none between Masbro' and Doncaster, although it was felt at Doncaster. From Masbro' south there were no shocks until near Chesterfield, and then felt everywhere to Claycross; then an interruption till S. of Ambergate. From Cromford to Bakewell it was felt; but not from Bakewell to Buxton. On the Nottingham and Lincoln line it was not felt N. of Collingham. On the Leicester and Hitchin line there was no shock S. of Bedford.

I may here be allowed to repeat some remarks I made yesterday (January 19), in the course of an address I delivered at the *soirée* at the Mansfield Mechanics' Institute.

"Perceptible shocks are much more common than generally supposed. Since the year 1800 there have been 3340 earthquakes, and from 1800 to 1850 no less than 110 shocks in the British Islands. On an average, a shock occurs somewhere on the earth's surface every six days, and one in every eight months is unusually severe, more earthquakes occurring in winter than in summer, the maximum being attained in January, and the minimum in July. In turning to our own country, one was felt throughout England in 1089, another in 1110 in Shropshire, in 1116 in Wales, in 1120 in Somersetshire, in 1134 in Kent, when flames issued from the earth in several places; another, severe, at Lincoln in 1142; one in 1249 in Somersetshire, another in 1250 at St. Albans, one throughout England in 1274, another on November 14, 1328—the greatest ever known in England—the Church of Glastonbury thrown down; another, on April 6, 1380, which lasted a minute, and did much damage to buildings; one in 1382, in the South Counties—many churches thrown down; one in 1426, in the Midland Counties, accompanied by thunder and lightning; another in 1428, very severe all over England; one in 1571, in Herefordshire—Marcley Hill (twenty-six acres in extent) was removed;

floor. (The direction of the corridor is indicated by a dotted line on the Map.)

In the City Prison the arched brick ceiling of the female corridor was also cracked.

At Holmar (a mile north of Hereford), the garden-wall of a gentleman was cracked quite through.

The feeling in Mr. E. J. Isbell's house was, that the sound and shock came in at the back of the house and went away by the front (another confirmation that the shock came from westward).

For the above particulars I am indebted to Mr. Isbell.

An outline Map is given in Plate XXII. of the parts of England visited by the earthquake, showing the part of the country where it was most severely felt, and which is indicated by a dark shade; and the places where it is reported to have been slight, or severe, or very severe are indicated by distinctive symbols. The whole area wherein it was noticed is enclosed within a dotted line, which reaches to Bury St. Edmunds in the E.; into St. George's Channel, and touching Ireland, W.; to Scarboro', N.; and to near Land's End, S.

APPENDIX.

From the mass of material before me, in part gathered from the public journals, in part, as I have already mentioned, from the ample contributions of Mr. Allpot, of the Midland Railway, and in large part from the cordial cooperation of my own friends and the public generally, in reply to my request published in the 'Times,' I have made selections, which I have put on record in a tabular form, classifying them into counties and groups of counties, with copious notes, and the authorities attached. These extracts might have been abundantly increased; but enough is given for the general purpose of this paper. The grouping could have been still further subdivided.

I. CENTRAL STATIONS. All places in—

1. Monmouthshire.
2. Herefordshire.
3. Staffordshire.
4. Worcestershire.

II. WESTERN STATIONS. All places in—

1. Lancashire.
2. Cheshire.
3. Flintshire.
4. Denbigh.
5. Caernarvonshire.
6. Irish stations.
7. Merioneth.
8. Shropshire.
9. Montgomeryshire.
10. Cardigan.
11. Brecknockshire.
12. Caermarthenshire.
13. Pembrokeshire.
14. Glamorgan.
15. Devonshire. (All places west of Exeter.)
16. Cornwall.
17. Sea-observations off Milford Haven and Cornwall.

III. EASTERN STATIONS. All places in—

1. Yorkshire.
2. Derbyshire.
3. Lincolnshire.
4. Nottinghamshire.
5. Leicestershire.
6. Rutland.
7. Warwickshire.
8. Northamptonshire.
9. Norfolk.
10. Cambridge.
11. Bedford.
12. Hertford.
13. Essex.
14. Middlesex.
15. Bucks.
16. Oxfordshire.
17. Gloucestershire.
18. Berkshire.
19. Surrey.
20. Kent.
21. Somersetshire.
22. Wiltshire.
23. Hampshire.
24. Sussex.
25. Isle of Wight.
26. Dorset.
27. Devon. (East of Exeter.)

I. CENTRAL STATIONS.

1. MONMOUTHSHIRE.

Place.	Sensation.	Sound.
Garway	Bed lifted vertically	Rattling thunder approaching and receding[1].
Lydney	Shaken frightfully in bed	Collision on railway.
Monmouth	Violent agitation; tremulous motion	Strong wind; artillery; house falling[2].
"	Distinct shock; falling out of bed	Garden-roller in hall, and stack falling; thunder[3].
"	Room shaken as if stout man fell	Lump-falling; mortar-falling.
"	Quivering tremor; bed upheaving	Furniture agitated[4].
Newport	Great vibration	Rumbling; distant thunder[5].
Usk	Trembling	Rumbling sound.—Rev. J. C. BAKER.

[1] Wall split diagonally, from E. at bottom to W. at top; bricks displaced; animals alarmed. Walls of upper rooms and ceiling cracked. Things shaken off table. Bed felt as if lifted at each corner perpendicularly. Part of a ceiling fell.

[2] Soundest sleeper awakened; people ran into the streets. Quivering motion caused sensation of giddiness. Morning clear, calm.—E. F. A.

[3] A rushing noise like a flue on fire, and Town Hall windows rattled. People ran into the streets. Wardrobes seemed about to fall. Dogs howling with fear. No damage done.—GEORGE WILLIS, M.D., Mayor.

[4] The sensation was sharp, startling, mysterious; lasted 6 or 8 seconds. Whole household roused. Momentary giddiness felt by some. General consternation. Numbers went into the streets.—VICARAGE, MONMOUTH.

[5] First shock at 3.10; second, stronger, at 3.30. The rumbling lasted 2 minutes; some thought it thunder; others, some explosion. Windows rattled. At Abercarn, an explosion in the colliery was imagined.—PUBLIC JOURNALS.

2. Herefordshire.

Place.	Sensation.	Sound.
Clifford	House rocked and trembled violently	Loud rumbling noises; volcanic-like groanings; departing thunder[1].
Hampton Bishop	House shaken violently, as if floor was lifted up	Rumbling and distant thunder[2].
Hereford	Earth violently shaken and uplifted	Rapid detonations; thunder; battery of guns fired underfoot[3].
"	Person seated in chair tilted up	A roar[4].
"	Beds upheaved	Heavily loaded waggons on paved road[5].
"	Houses violently shaken; earth rising and sinking; many had to cling to railings for support.	Unearthly[6].
"	Earth rising and sinking; could not stand without support.	Thunder; explosion or collision on railway; rumbling[7].
"	House shaken violently	Loud clap of thunder.
"	House shaken, as if huge block hurled against it	Receding thunder[8].
"	Ground shaken; beds shaken	Rumbling noise, as if railway-engine on road[9].
Kington	House shaken violently; bedsteads vibrated	Loud rumbling; terrific explosion, louder than is produced by the heaviest artillery[10].
Ross	Wall appeared to be falling; chair tilted up, and doors of wardrobe thrown open.	Heavily laden waggon driven rapidly[11].
Wormbridge	House shaken; people awakened	Explosion, as if roof had fallen in[12].

2. HEREFORDSHIRE (*continued*).—NOTES.

[1] About 2.30 (as near as I can guess).—ED. C. DERING.

[2] 3.18 to 3.20. Windows and crockery shaken; all in bed aroused by fright. Shock evidently from N. or N.E.; rumbling lasted some seconds after shock; duration 7 to 8 seconds, including 3 seconds of shock.—T. W. W.

[3] 3.20: from W.; approached with shaking, then a crash; a dreadful *lift*, as if from some tremendous force beneath; bells rung; ceilings cracked; glass and china broken; prison-wall shaken; crack re-opened; arch-roof cracked; Enhall Colliery filled with water.—E. J. ISBELL.

[4] From N.N.W.; seated, and up went right leg of chair; duration 3 seconds; retreating roar 5 seconds; total duration 10 seconds.—T. W. WEARE, F.R.A.S.

[5] Night calm, clear, cloudless; $34\frac{3}{4}$°Fahr.; two shocks 3.20 A.M.; sound first; it increased and became more terrible after the motion ceased; described as "unearthly," "supernatural," "appalling;" policemen thought ground sinking, and held on; houses shaken; bells ringing; people roused and terrified; glass and china thrown down and broken; from S.W.,—some say N.W.—LOCAL JOURNAL.

[6] Whistling noise; earth on the move; windows shaking; feeling as if senses were gone, and churches and houses coming on; clap, like an engine bursting; felt very ill after.——Report like thunder; houses seemed to move; sound like explosion on railway, of an engine running against a bridge.——Noise like whirring of wind; dreadful crash, like thunder; tiles and windows rattled.——Great noise, like thunder, but more terrific; all of a shake, and clung to a gate; trees shook very much; birds flew out, and began chirping and singing.——Sound like shunting a train, and then a tremendous explosion; windows rattled; bricks fell.——Fearful noise, followed by a shock, and a feeling as if sinking into the earth; then a tremendous crash, as if from the heavens, and a louder report, as if a house had fallen; sleepers aroused, and at their windows and doors.——A heavy rumbling noise, as if a railway accident and explosion had occurred.——Fowls made a noise; a whistling heard in the air; a great noise heard coming; apple-trees shook as if fruit would all fall.——Noise as if a house had fallen; bells rang, glasses fell; ground seemed to go up and down.——Rumbling noise; two policemen, a yard apart, were shaken together, and held on to keep up.—HEREFORD POLICE REPORTS.

[7] Lasted a minute; from S.W.; air still; stars shining.—ED. JARSON, Rector of Thruxton.

[8] As if the house sundered and broken up; a "settling" followed; mortar, bricks, and ceiling cracked; time 3.20 local, slower than railway.—Q. C., ST. OWEN'S, HEREFORD.

[9] Felt quite in a "dithers;" shock seemed along tops of houses.——Cattle and dogs made a great noise.—HEREFORD POLICE REPORTS.

[10] Explosion as if of gunpowder before shock; after it a loud rumbling; from N.W.; everything vibrated, nothing displaced; expected wall to fall in; poultry disturbed; cocks crowing.—HENRY MILES.

[11] West wall seemed to lean over; chairs tilted off two legs 4 inches in same direction; wardrobe-doors flew open.—R. F. LEWIS.

[12] 3.30: moonlight, cloudless.—D. G. GEORGE.

3. Staffordshire.

Place.	Sensation.	Sound.
Barton and Walton	Windows shaken, and beds rocked	Rushing wind.—J. Allport.
Burton-on-Trent ...	Beds shaken; sleepers awakened; supposed thieves in house.	Low, distant, rumbling sound[1].
Congleton	Earth shaken; quivering; people awakened	Loud rumbling; concussion[2].
Croxall	Bed shaken.	
Haselour	Bed shaken; people aroused	Distant thunder or explosion.—J. A.
Longton...............	Rocked in bed.—T. A.	
Pound	Upheaving, as if body raised three times	Low murmuring; person heavily loaded stepping rapidly upstairs[3].
Parkfield Iron Works	Concussion, waking whole household	Concussions[4].
Stafford	Motion of earth; vibration; as if person under bed	Collision on railway.
"	....	Rumbling noise; collision on railway[5].
Stone	Bed rocked	Loud explosion, like cannon, in room below[6].
Wicknar Junction...	Signal-box shaken....................................	Low rumbling.—J. A.
Wordsley to Wolverhampton.	House severely shaken[7].	
Wolverhampton ...	Vibration[8].	
" ...	Vibration; house shaken to its foundations	Cracking and creaking noises[7].
" ...	Violent shaking...	Cracking and creaking, as if houses strained and shaken[8].

3. Staffordshire (*continued*).—Notes.

[1] Several clocks stopped; weather calm, and afterwards unsettled and stormy.——Shock felt about 3.20. Vibrations continued several seconds. —E. Brown.

[2] Time, between 3.20 and 3.25 A.M.: whole town quivered; noise sufficient to awaken many of the inhabitants. Watchmen at mills and factories alarmed; one man, under the impression that robbers had broken in, fetched his blunderbuss. Crockery was rattled, and chimneys thrown down.—Local Journal.

[3] Time, 3.30: house situated on some of the highest ground in Staffordshire, three miles from the Black Country.—John Foster.

[4] None of the men in mines half a mile distant felt anything.—Henry Marten.

[5] Time, 3.20 A.M.: very decided motion of earth felt in Stafford, and for considerable distance round. Lamps at station swung about; an inspector, who had gone home, hurried back, fancying there was a collision. Jingling of keys at gaol excited fears of escape of prisoners. Vibration E. to W. Felt at Gnosall, seven miles W., and at Brick House, two and a half miles N.E. of Stafford.—Local Press.

[6] About 3 A.M.: bed rocked in the direction of N. and S., quick undulatory motion; brass rings on mahogany rods rattled together, as if hand passed along several times; duration about half a minute.—Eldred Woodland.

[7] 3.30 A.M.: servants aroused; ceilings cracked, and small pieces of plaster thrown down, and also articles of furniture; bells set ringing.—H. H. H.

[8] 3.25 A.M.: two shocks felt, each lasting several seconds; vibrations increasing till windows rattled vigorously, and then gradually died away in pulsations; nearly every one aroused. First shock between 3.22 and 3.23 A.M.; after elapse of a minute, a second shock, more severe than the first. Tremendous, rapid, and undulatory motion, apparently proceeding from N. and S.; vibration of water-jugs, glasses, &c.; straining and settling of house. Similar occurrences at Wrottesley Hall, Teddersly, Bilston, and Sedgley.—Times and Local Journals.

4. Worcestershire.

Place.	Sensation.	Sound.
Alvechurch	House shaken; people alarmed	Rumbling[1].
Barnet Green	House shaken	Train in the distance.—J. A.
Blackwell	„ „	„ „ „ —J. A.
Bromsgrove	....	Goods train passing on wooden bridge.—J. A.
Bredon-on-Hill	Bed shaken violently, as if some one underneath[2].	
„	Two shocks felt..	Passing train.
Dunhampsted	House and beds shaken; two shocks felt	„ „ —J. A.

Eckington	......	Distant thunder.—J. A.
Great Malvern	......	Report, like noise heard at Sorrento on occasion of eruption of Vesuvius.—S. M. King.
"	General consternation	Windows violently rattled[3].
"	Swaying to and fro	Rumbling, growing fainter, and dying away in distance.
King's Norton	Shaking, as if near passing train	Rumbling; burglars.
Moseley	Houses and beds shaken.—A. T.	
Prestwood	Violent vibration; bed shook and rocked like a cradle.	Concussion; noises of animals[4].
Worcester	Houses shook, and beds oscillated	Rumbling noise, like passing train[5].
"	......	Rumbling; explosion.
Stoke Works	......	Escape of steam.—J. A.
Upper Swinford	House shaken; family aroused[6].	
Wadboro'	Motion like rocking of cradle	Distant thunder.—J. A.
Wordsley	Violent shaking of bed, and quivering of house and furniture.	Heavy explosion beneath cellars[7].

[1] Direction W. People awakened and much alarmed; one time-piece stopped, and another lost time.—J. A.

[2] Severely felt; one person had much earthenware and crockery broken. ——Two shocks felt, direction S. to N.; tree *said* to have sunk in ground up to branches.—J. A.

[3] Windows violently rattled; railway-signal said to have been displaced; general consternation.—W. W. Fife. Loud report, followed by a slight swaying to and fro for about 10 seconds, gradually growing fainter and dying away. Sound seemed to travel from N. to S.—Excussus Somno.

[4] Smart shock between 3 and 4 A.M.; vibration for several seconds. Game in preserves alarmed and terrified; shaken from roosts by concussion of atmosphere; affrightedly crowing.—Joseph Jordan.

[5] Chimney-pots thrown down, 3.25 A.M.; inhabitants alarmed by violent shaking of houses, rattling of crockery and furniture, and oscillation of beds; also felt sensibly towards Pershore and Droitwich. Barometer fell all day: no rain; sharp frost at night.—Local Press.

[6] 3.30 A.M.: family aroused, and dogs appeared affected by the shock. Several ceilings cracked, and plaster fallen on carpet. Residence a mile from the coal-measures, and is on the red-sandstone formation.—H. H. H.

[7] About 3.15 A.M.: two shocks felt; windows rattled; furniture and whole house quivered; silver rattling for some time. Appeared as if heavy explosion beneath cellars accompanied second shock.—R. B. Girdlestone. Felt severely at Spetchley, Stourbridge, Wednesbury, Walsall, and Kidderminster.

II. WESTERN STATIONS.

1. Lancashire.

Place.	Sensation.	Sound.
Birkenhead	Houses shaken; beds almost horizontal[1].	
Egremont	" " " "	
Liscard	" " " "	
Liverpool	Bed upheaved, as if thrown on floor.—W. H. Nevill.	
"	Ground upheaved; houses oscillated.	
"	" " beds shook[2].	
Manchester	Bed and furniture shaken[3].	
Southport	Tremulous motion; bedstead undulated violently	Peculiar rumbling noise[4].
Ulverston	....	Heavy luggage-train on railway[5].

[1] No noise, but upheaving of earth and oscillation of houses; surgeon, visiting sick lady, felt house shake; left his patient, and made for the street. Houses suffered a good deal by the breaking of ornaments, glass, &c. Similarly felt at Bootle, Seaforth, Waterloo, and Crosly.—Local Journal. A shock felt at Lancaster, 3.30 A.M.—Christopher Johnson.

[2] 3.22 A.M.: sensation of moving from N. to S., and then as if thrown on floor to S. 100 feet above sea.—W. H. Nevill. 3.25 A.M.: upheaving of earth; beds lost their customary equilibrium; clocks stopped; bottles of wine shaken out of bins; articles of a fragile nature broken, and bells set ringing; hens shared the fright of the household. One or two cases of premature confinement.—Local Journal.

[3] Severe shock felt; families aroused by noise; bed, hangings, curtains, and furniture perceptibly shaken. Similarly felt at Bowdon, Bolton, and Ashton.

[4] 3.20 A.M.: residents awaked by tremulous motion of their dwellings; upper stories most affected; toilet-ware distinctly rattling.

[5] Two clocks stopped.—Rev. R. Gwillym.

2. Cheshire.

Place.	Sensation.	Sound.
Acton	Giant shaking bed violently[1].	
Chester	House rocked; bed swayed from side to side[2].	
Hawarden	Vibration; tremor of bed	A thump, like heavy piece of furniture striking wall of room.—T. Moffatt.
Nantwich	Houses trembled, and furniture routed[3].	

[1] Between 3.30 and 4 A.M.: smart shock felt; windows and bedsteads shaken violently.—W. F. Shaw.

[2] 3.50 A.M.: air sultry, and sky lurid and hazy; shock, which appeared to make house rock to its foundations, and bed to sway to and fro; two other shocks, of less violence, followed.

[3] Severe; bells rang; door slammed to; glass rattled.

3. Flintshire.

Ruthin	Many persons awakened.	
St. Asaph	Person thrown out of bed.	

Severely felt in Vale of Clwydd and Mold, lasting some time.—Editor of 'Oswestry Advertiser.'

4. Denbigh.

Place.	Sensation.	Sound.
Denbigh...............	Many persons awakened[1].	
Wrexham	....	Rumbling noise; barrels rolled about.

[1] A looking-glass thrown down.—Editor of 'Oswestry Advertiser.'

5. Caernarvonshire.

Coes-faen	Bed shaken, and uplifted in peculiar manner ...	Peculiar rumbling sound, like cart passing over tunnel[1].
Caernarvon	....	Heavily laden waggons passing along streets.
Aberystwith	Startled from sleep	No noise heard.—J. F. F. S.

[1] Peculiar rumbling sound preceded shock; sound dying away as soon as shock felt; direction of sound N.E., or a point or two more E. House built in exceptionally strong manner on point of rock jutting out into estuary of the Manddach, and exposed to full force of W. gales sweeping across channel and Cardigan Bay. Windows shaken more than in most violent gale.—Charles Jones. Shock felt in Bangor, but not severely.—Editor of 'Oswestry Advertiser.'

6. Irish Stations.

Place.	Sensation.	Sound.
Enniscorthy	Bed moved horizontally, and upheaved floor giving way[1].	
Rathmines	Tremulous motion....................................	Falling of some heavy article[2].

[1] 2.50 A.M. (Irish time): three and a half miles from sea; twofold motion of bed, from side to side horizontally, and at same time shaken upward; doors of wardrobe rattled, and glasses jingled.—A. Bettesworth Perry. [2] 3.2 A.M.: supposed house had been entered.—'Daily Telegraph.'

7. Merioneth.

Barmouth	Sensibly felt	Rumbling.—Local Press.

8. Shropshire.

Place.	Sensation.	Sound.
Bridgenorth	Inhabitants awakened.	
Dorrington	Room rocked	Rumbling[1].
Elerton	Ground trembled.—Mrs. H. E. Palmer.	
Ludlow	Many persons awakened.	
Newport	Room shook and trembled; like ship pitching	Most fearful; train laden with iron passing under house[2].
"		Heavy waggon passing; distant thunder.
Shrewsbury	Beds moved laterally.—J. A.	

[1] 3.30 A.M.: furniture rattled; was able to distinguish natural from artificial sounds.—'Times.'

[2] Between 2 and 3 A.M.: sound grew gradually louder, and then all was still; drawers moved up and down, and everything rattled; on 2nd, aurora; on 5th, 3.30 P.M., most extraordinary darkness came on—an inky darkness, which lasted till 7 P.M.; very little rain. At 10 P.M., calm, starlight, and sharp frost.—Mrs. H. E. Palmer. Felt slightly at Oswestry and Wem, and at Whitchurch. Some declare there was a shock soon after midnight, as well as at 3.30 A.M.

9. Montgomeryshire.

Newtown	Bed moving; standing difficult; ground undulating.	Peal of thunder[1].
"	Violent shaking of room.	

[1] Bed felt moving from E.N.E. to S.S.W.; person felt a difficulty in holding himself on ground, undulating beneath his feet.—John E. Wood.

At Welshpool, on 8th, a violent thunder-storm occurred, accompanied by vivid lightning and terrific thunder-claps, and rain fell in torrents; it extended to Newtown, and raged there even more violently.—Editor of 'Oswestry Advertiser.'

10. Cardigan.

Place.	Sensation.	Sound.
Cardigan	People disturbed and alarmed.—Rev. G. Thomas.	
New Quay	Many persons alarmed[1].	

[1] Very severe; but Coast-guard felt nothing.—R. Matthews.

11. Brecknockshire.

Place.	Sensation.	Sound.
Brecon	Streets pitched; moved as if blister underneath[1].	
Builth	House shaken[2].	
Hay	Bed lifted and shaken; as if house lifted up and set down.	Railway train; carriage on boards; thunder; falling body[3].
Llan Thomas	Houses trembled; alarm and terror	Loud, long-sustained clap of thunder[4].

[1] Bottles thrown down in one place, and plates broken in another.

[2] Severe; water thrown out of tumbler, and night-light extinguished. House three or four miles distant, across valley, felt nothing.—Rev. T. W. Webb.

[3] Direction of sound uncertain; some referred it to W., others to N.E., and others to S.; differed from thunder in not being confined to one quarter; compared to still, even roll, and to cracking thunder passing over house. Some felt shock, and heard no noise; others heard noise, but felt no shock. Houses shook; doors and windows clattered; bed lifted apparently from S.; pheasants crowed; board struck up from floor; chimney unsettled, and tiles thrown down; gas extinguished at Malvern; wall of oven cracked; beautiful clear night. House on N. edge of Devonian formation, on a long slope rising from valley of the Wye to hills probably 600 or 800 feet, connected with Black Mountains, about five miles S. of the house, culminating in their interior in a summit of 2545 feet above sea.—Rev. T. W. Webb.

[4] 3.30 A.M.: night calm and cloudless; shock seemed to come from S.W. to N.E., continued for several seconds, and caused houses to tremble, windows to rattle, and articles of furniture to move.—W. Jones Thomas.

Crack observed in church at Llandivaly, and at Llandefailoy; both walls and ceilings cracked.—Rev. T. W. Webb.

12. Caermarthenshire.

Place.	Sensation.	Sound.
Llandovery	People aroused from sleep	Loud rumbling noise[1].
Llanelly	Quaking; oscillation of room	Roll of distant thunder[2].

[1] 3.22 A.M.: moon shining brightly, not a cloud to be seen, and the country white with hoar frost.

[2] 3.35 A.M.: shock lasted from 10 to 15 seconds, and was characterized by two slight lulls, which seemed almost to divide it into three; continuous roll like distant thunder; three quakes equal in force and duration; oscillation of every article of furniture; crockery-ware thrown down and broken; nearly all the inhabitants awoke. Accounts vary as to its severity in different places. Felt severely on a mountain about four miles to northward.—Rhys P. Jones.

13. Pembrokeshire.

Lampeter	....	Caravan entering town; carriage on gravel walk[1].

[1] Light articles displaced; pole resting against wall thrown down; pile of books resting against N.-S. wall thrown down, whilst those resting against E.-W. wall were not disturbed.—R. Matthews.

14. Glamorgan.

Place.	Sensation.	Sound.
Llandaff	Bed lifted up and let fall	Loud crash; heavy article falling[1].
Merthyr Tydvill	Thousands awakened	Waggons rapidly propelled through working of mine[2].
Swansea	Houses shaken.	
"	Rolling motion of bed; room rocked; feeling of helplessness.	Deep rumbling; heavy traffic in street[3].

[1] Pictures moved all one way from perpendicular; wardrobe doors opened.—G. Williams.

[2] Thousands awoke; miners, working 1200 feet under the surface, were very much alarmed; no oscillation noticed.—E. H.

[3] 3.28 A.M.: moon and stars shining brightly; waters of bay placid, and moderate wind blowing; bed affected, as it were, by eight or nine distinct rolling motions; room rocking to and fro; water-jugs and basins jingling; bottles moved; three faint vibrations felt, seemed as if from E. to W.; violent ones from reverse points.—George Grant Francis.

15. Devonshire (all places W. of Exeter).

Ashburton	Tremulous motion of room and furniture[1].	
Barnstaple	Violent shaking of beds[2].	
Tavistock	Houses trembled and shook	Loud rumbling noise underground[3].

[1] About 3.30 A.M.: noise resembling burglars entering house, followed by tremulous motion of room and furniture; duration, 2 or 3 seconds; morning unusually bright and clear, slight frost, and exceedingly calm.—J. S. A.

[2] About 3.30 A.M.: severe shock felt; windows shook; water-bottle thrown down, and trinkets thrown off chimney-pieces; duration not many seconds.

[3] 3.25 A.M.; weather exceedingly still and calm; atmosphere clear, no rain falling; commenced with cracking noise, and house appeared to tremble; an interval of 2 or 3 seconds and trembling recommenced, and continued for about 15 seconds, gradually increasing in severity until it ceased.—W. F. Collier.

16. Cornwall.

Place.	Sensation.	Sound.
Ilchester	Bed shaking[1].	
Launceston	Bed and furniture shaken[2].	
Truro	Beds rocked, as if some one shook them[3].	

[1] Sound like dog's-tail rapping on wooden floor—perhaps pendulum striking side of case; crack noticed across hard-laid carriage-road, from N.E. to S.W., traceable till lost in soft soil amongst bushes; appeared to have been made by heaving movement.
[2] 3.25 A.M.
[3] 3.20 A.M.: thought thieves getting in by window; curtain-rings rattled; one bed, pointed N.E. to S.W., was rocked longitudinally; another, S.E. to N.W., rocked crosswise, more roughly, as if some one shook it. On 6th, rain 0·5; in eight days, 5th to 13th, rain 3·84 inches.—Dr. C. Barham.

At Penzance, sea very much agitated; man-of-war drifted from moorings out to sea; felt slightly at Milton Abbott and Helston.

17. Sea-observations off Milford Haven and Cornwall, &c.

Off Milford Haven...	Concussion, as if vessel striking upon a rock[1].	

[1] Twenty miles from Milford Haven.
Norris Castle, Isle of Wight, 300 yards from beach, and 100 feet above the sea, gentleman felt shock at 3.22 A.M., which lasted from 5 to 7 seconds.—W. C. Mann, Esq.

III. EASTERN STATIONS.

1. Yorkshire.

Place.	Sensation.	Sound.
Aunley	....	Low rumbling.—J. A.
Doncaster	....	Distant thunder.—J. A.
Highfield	Some one thumping wall of adjoining room	Boards creaking, or timber settling[1].
Harrogate	Bed rocking.—G. K.	
Keighley	Bed shook.—J. A.	
Leeds	Bed shaken; vibration[2].	
Malton	Impression of falling to the east.—C. Monkman, Esq.	
Marwood	Bed rocking; rush of blood to head	Like beating on a long plank[3].
Rugby	Violent shaking of beds	Rumbling vehicle passing[4].
Sledmere	Sinking motion; ground moving; falling sensation[5].	
Wakefield	Vertical and horizontal motion	Slight rumbling[6].
Yorkshire — Chatt Moss district.	Vibration; falling towards E.	Rumbling; distant railway-train.—C. Monkman.
Yorkshire Wolds	Vibration; falling towards N.E. or E.	Rumbling; railway-train in motion[7].

[1] About eight thumps heard, in divisions of four; the last slower than the first, and took 2½ seconds.—N. R. Baxter.

[2] 3.30 A.M.: slight shock felt; dressing-table covered with glazed calico crackled with the vibration. A retired soldier states he was suddenly seized with a feeling of sickness, similar to what he had felt on the occurrence of earthquakes in India.—'Leeds Mercury.'

[3] Two shocks; person took a blue pill under idea that his head was being filled by a rush of blood.—Rev. F. Mules.

[4] About 3.30 A.M. shock felt; family awakened by beds shaking, and windows clattering; an almost supernatural stillness prevailed.—'Alpha.'

[5] Ground apparently moving towards W., causing persons to fall, or to feel sensation of falling towards E.—C. Monkman.

[6] Sound apparently moving from S. to N.; beds lying E. and W.; small articles jingling; motion wave-like in character; a vertical and horizontal movement and sideway motion, and back again, without any sense of vertical displacement.—W. R. Milner, Esq.

[7] 3.30 A.M.: atmosphere warm and unnaturally still; rumbling noise, instantly followed by a vibratory motion; ~~caused sensation of falling~~ towards N.E. or E. On Yorkshire coast, a false tide is reported to have occurred. Felt slightly at Brightside, Huddersfield, and Norton.

2. DERBYSHIRE.

Place.	Sensation.	Sound.
Alfreton		Rumbling, almost roaring[1].
Belper	Houses shaken	Thunder[2].
Borrowash		Train running off line[3].
Chesterfield	Bed shaken[4].	
Coxbench	" "	Buzzing; hissing; escape of gas or steam[5].
Darley Dale	Houses and beds shaken	Rumbling.—J. A.
Derby		Vehicles passing in street[6].
"	Violent rocking of beds; houses giving way	Burglars entering premises[6].
"	Violent shaking of bed; raised in bed, as if some one underneath[6].	
Draycot		Rumbling.—J. A.
Duffield	House shook as if it would fall.—J. A.	
Gresley	Bed shaken	Distant thunder.—J. A.
Ilkeston	House and furniture violently shaken.—J. A.	
Long Eaton		Rumbling.—J. A.
Matlock	Bed shaken	" [7].
Ripley		" [8].
Sawley	Bed shaken	Running train[9].
Sandiacre		Low rumbling[10].
Spondon		Rumbling.—J. A.
Swadlincote	Beds shaken; alarm	Heavy rumbling.—J. A.
Toton	Beds shaken	Rumbling[11].
Trent	Huts shaken	Passing train.—J. A.
Willington	Houses trembled	Thunder[12].
Whatstandwell		Loud rumbling[13].

[1] Moveables rattled, and glass broken at Alfreton Hall.—J. A.
[2] Pots were rattled; direction S.—J. A.
[3] Felt severely; direction N.W.; dogs frightened.—J. A.
[4] Clock stopped; bells rung; an alarum went off before its time.—J. A.
[5] Direction N.W. to S.E.; weather calm.—J. A.
[6] Direction S. to N.; town water very muddy that morning.——3.20 A.M.: severe shock; shaking continued for several minutes; night very calm.——3.20 A.M., one mile W.N.W. from centre of town of Derby: violent shaking continued for 3 or 4 seconds; a most beautiful autumnal morning; moon and stars shining brightly, not a breath of air stirring, and vegetation covered with frost.—W. H. B.
[7] Direction N. to S.; night very still.—J. A.
[8] Tuning-fork lost its tone (?).—J. A.
[9] Strongly felt; direction W.; windows and crockery shaken.—J. A.
[10] Severely felt; two shocks, the last making windows, doors, and crockery rattle.—J. A.
[11] Severely felt; direction N. to S.; clock stopped; burglars suspected.—J. A.
[12] Direction W. to E.—J. A.
[13] Two clocks stopped; grocers' weighing-beams rattled.—J. A.
At Bakewell weather remarkably fine; windows and hanging bird-cages rattled. Pinkston, direction S; Rowsley, E. to W.—J. A.

8. Lincolnshire.

Place.	Sensation.	Sound.
Kirton Lindsey	Bed slightly, but distinctly, shaken	Unusual noise.—W. W. Bury.
Lincoln	House violently shaken	Heavy dray passing at full gallop[1].
Stamford	Beds shaken	Passing train.—J. A.
Wyham	Shivering; bed heaved gently	Low rumbling; thunder; something heavy being dragged below[2].

[1] Between 3 and 4 A.M., suddenly awoke by fearful noise, as if some one breaking into house; ceiling of a bed-room fell in.—M. S.

[2] 3.30 A.M., slight shiver seemed to pass all round walls of room.—Miss Iles. Felt also at Edmondthorpe, Little Dalby, and off coast.

2. Derbyshire.

Place.	Sensation.	Sound.
Alfreton		Rumbling, almost roaring[1].
Belper	Houses shaken	Thunder[2].
Borrowash		Train running off line[3].
Chesterfield	Bed shaken[4].	
Coxbench	" "	Buzzing; hissing; escape of gas or steam[5].
Darley Dale	Houses and beds shaken	Rumbling.—J. A.
Derby		Vehicles passing in street[6].
"	Violent rocking of beds; houses giving way	Burglars entering premises[6].
"	Violent shaking of bed; raised in bed, as if some one underneath[6].	
Draycot		Rumbling.—J. A.
Duffield	House shook as if it would fall.—J. A.	
Gresley	Bed shaken	Distant thunder.—J. A.
Ilkeston	House and furniture violently shaken.—J. A.	
Long Eaton		Rumbling.—J. A.
Matlock	Bed shaken	" [7].
Ripley		" [8].
Sawley	Bed shaken	Running train[9].
Sandiacre		Low rumbling[10].
Spondon		Rumbling.—J. A.
Swadlincote	Beds shaken; alarm	Heavy rumbling.—J. A.
Toton	Beds shaken	Rumbling[11].
Trent	Huts shaken	Passing train.—J. A.
Willington	Houses trembled	Thunder[12].
Whatstandwell		Loud rumbling[13].

[1] Direction S. or S.W. Ceiling of a room cracked.—J. A.

[2] Direction E. to W. A person first turned on left side, then on right. E. side of bed first raised. Table with leaves much rattled. Felt more on high than low ground, and more in the hard and rocky parts than in the soft earthy parts.—J. A.

[3] Direction N.E. to S.W.; weather calm, and night light.—J. A.

[4] Washstand very much shaken; thought robbers had broken in, or children fallen out of bed.—W. Hallam.

[5] Bricks fell down a chimney; strong wind.—J. A.

[6] Starlight and scarcely any wind. Bedroom door forced open.—J. A.

[7] Direction W.; windows, doors, &c. rattled. 3.15 A.M., sound approaching from S.W., continued for about 20 seconds, and was succeeded by a sort of violent push from same direction; apparent effect of this push was to raise first one side of house, and then the other. This motion occupied about 10 seconds, when there was a resumption of the first sound of a carriage in motion, only on the other side of house, and occupying about the same time as the first.—J. H.

3.25 A.M., direction of wave appeared from W. to E.—John Place.

[8] Direction S. to N; weather calm and starlight.—J. A.

[9] Bed quivered three or four times, and one window rattled with much noise; then all was still.—Col. H. F. Ainsley.——Felt also at Pye Bridge and Burton Joyce. At Beeston person nearly rolled out of bed.—J. A.

5. Leicestershire.

Place.	Sensation.	Sound.
Asfordby	Houses and beds shaken	Rumbling[1].
Ashby-de-la-Zouch..	Beds shaken.—J. A.	
Bagworth	Person rocked as if in cradle	Rushing wind; heavy goods-train.—J. A.
Bardon Hill	....	Passing train.—J. A.
Brooksby	Beds shaken	Thunder.—J. A.
Broughton............	Beds shaken.—J. A.	
Coalville..............	....	Heavy vehicle passing[2].
Coleorton	Beds violently shaken.	
Cossington Gate ...	....	Distant thunder.—J. A.
Desford	....	Passing train.
Frisby	Beds shaken	Rumbling.—J. A.

5. LEICESTERSHIRE (*continued*).

Place.	Sensation.	Sound.
Glen		Distant volley of musketry.—J. A.
Glenfield	Trembling of the earth.—J. A.	
Hinckley	Beds shook[3].	
Kibworth		Rumbling.—J. A.
Kirby Muxloe	Houses and beds shaken	Wind or distant thunder.—J. A.
Loughborough	Bedsteads shaken	Ominous sound[4].
"		Falling timber.
Leicester	Vibration; quick motion of bedstead[5].	
"		Strange rumbling.
Market Harborough	Peculiar vibration of beds[6].	
"	Vibration; indescribable movement of bed[6].	
Melton Mowbray	House shaking; beds trembling	Mysterious rumbling.—J. A.
Merrylees	Bed shaken	Rumbling.—J. A.
Moira	Trembling of house	Distant thunder.—J. A.
Ratly	Beds shaken	Heavy lumbering[7].
Rearsby		Passing train[8].
Sileby		Rumbling.—J. A.
Thringstone	Houses much shaken	Some one knocking violently at door.—Mr. W. HALLAM.
Westbridge		Distant thunder.—J. A.
Wigston	Beds shaken	Passing train.—J. A.
Wymondham	Person shaken; house violently agitated[9].	

[1] Direction N.E.—J. A.

[2] Direction N.; two shocks felt.—J. A.

[3] Many rose from beds, and children secreted themselves under beds.

[4] 3.23 A.M.; two shocks felt: first had scarcely subsided before second was distinctly felt, and which made heavy report; medical men went to their windows to see who wanted them.

[5] Vibrations of floor of room by heavily laden waggons passing building, small in comparison to those caused by earthquake; in fact, too small to measure except by using a basin of mercury with points placed about it, for noting the height of waves produced.—E. T. LosEBY.

[6] Vibrations lasted 3 or 4 seconds; direction W. to E.; clock stopped; swing of pendulum E. to W.; bells rang and doors shook.

3.25 A.M., peculiar vibration of doors of a hanging press, mounted upon friction rollers; continued 3 or 4 seconds.—S. WATSON COX.

[7] Mangle set rolling.—J. A.

[8] Direction N.E. to S.W.—J. A.

[9] Whole house violently agitated for a second or two; neither a trembling nor a rocking, but seemed to be a wide lateral movement of whole area.—JOHN BACON.

6. RUTLAND.

Place.	Sensation.	Sound.
Ashwell	Houses shaken	Distant thunder.—J. A.
Manton	Houses shaken	Distant thunder.—J. A.
Oakham	Bed falling; bed lifted; violent concussion	Collision on railway; explosion[1].

[1] Dog affected; stack of chimneys N.W. of the side of bed seemed to be falling; violent concussion of floor. No collision on railway or explosion of gas could cause such an effect.—Rev. H. E. FINCH. Distinctly felt at Uppingham.—J. C. T.

7. Warwickshire.

Place.	Sensation.	Sound.
Birmingham	Houses and beds shaken	Kind of rattle[1].
„	House shaken to its foundation	A dreadful rattle[1].
„	Vibration; houses shaken	Grating; low rumbling[1].
Camphill	Houses and beds shaken	Distant thunder.—J. A.
Coleshill.........	Beds shaken.—J. A.	
Castle Bromwich ...	....	Rumbling.—J. A.
Dudley	Beds violently shaken	Rumbling; over train in tunnel[2].
Forge Mills	Beds shaken[3].	
Hampton	Beds shaken	Rumbling[4].
Tamworth	Motion of vessel at sea; feeling of nausea	Distant train passing.—J. A.
Water Orton.........	....	Railway collision.—J. A.

[1] Direction W.; bells ringing, and articles of furniture thrown down. —J. A.——About 3 A.M. a sharp shock lasting 5 or 6 seconds. Moon shining brightly; and air clear, with frost. Felt also at King's Norton, Sutton, Tipton, and Rowley Regis.—J. L. P.——3.23 A.M., two shocks felt; first slight, lasting about 5 seconds; second much more violent, shaking house from its foundations. There was little real noise, but rather a sense of sound, caused by the sensation that everything around was violently agitated.—R. C. Barrow.——3.35 A.M., two distinct shocks; second the most violent. Walls were seen to move; in some instances substantial buildings disturbed as much as old houses are by passage of heavy waggon along the street. In the rural districts it was more perceptible than in Birmingham.

[2] Most severely felt; many congregated in streets; doors burst open; crockery-ware broken, and clocks stopped.

[3] Direction W. to E.; chains rattled, and bells rung.—J. A.

[4] Direction S.E., weather frosty; wind changed from W. to N. between 6 and 8 A.M.—J. A.——At Coventry, Exhall Colliery was found full of water on morning of 6th.—E. J. Isbell.——Felt at Wilnecott.—J. A.

8. Northamptonshire.

Place.	Sensation.	Sound.
Brixworth	Beds shaken violently[1].	
Finedon	Bed uplifted.—J. A.	
Isham	Trembling	Passing vehicles[2].
Wellingborough		Distant passing train.—J. A.

[1] Between 3 and 4 A.M.; inhabitants aroused by smart shock, which shook beds and furniture in violent manner; lasted but a few seconds; first impression was that some one was treading heavily and violently along adjoining room or passage.—Charles Frederick Watsons.

[2] Bells rang, and everything trembled; night still and calm.—J. A.

Felt at Kettering and Warrington. At Guildsborough, one woman said, "I wasn't sure it was an earthquake, or else I should have fetched the doctor."

9. Suffolk.

Bury St. Edmunds		Heavy waggon passing slowly; hail among trees[1].

[1] Night fine, with no wind.—S. Young.

10. Cambridge.

Place.	Sensation.	Sound.
Cambridge............	Some one walking in adjoining room.—J. C. Adams.	

11. Bedford.

Place.	Sensation.	Sound.
Bedford	Bed shaken	Heavy goods-train passing.—J. A.

12. Hertford.

Place.	Sensation.	Sound.
Henlow & Hitchin...	House trembled	Passing train.—J. A.

13. Essex[1].

[1] No report from this county. Told it was not felt about Braintree, Halstead, Gosfield, or Chelmsford.—E. J. L.

14. Middlesex.

Place.	Sensation.	Sound.
Bayswater	Sharp; three little quivers.	
Isleworth	Slight tremor	Heavy waggon passing[1].
London, S.W.	Vibration	Like a Pickford's van passing[2].
" W.	Vibration of bed	Rumbling of heavy waggon or railway-train.
" W.	Rocking of bed[2].	
" N.	Gradual motion of bed from side to side[2].	
" N.	Bedstead violently shaken[2].	
Notting Hill	Singular tremor; horizontal shake[2].	
Stoke Newington	Bed violently shaken; vibration[3].	
Twickenham	Oscillatory motion; very peculiar sensation[4].	

[1] Cushioned to great extent against anything but a very violent earthquake by a geological substrata.—Walter Beck.

[2] As if gates opened and shut violently opposite house. 3.30 A.M., awoke from sleep by violent shaking of bedstead and doors of a large wardrobe; duration 3 or 4 seconds. Tremor very singular in its character; a horizontal shake accompanied by an extraordinary sensation down left side and leg on side I was lying.—J. C.

[3] 3.23 A.M.: vibrations did not last for more than 2 or 3 seconds, but motion very extraordinary.—R. F.

[4] Tremor very perceptible; oscillatory motion appeared from E.N.E. to W.S.W., lasting 3 seconds or rather less; no sound heard after shock, but cannot say whether any preceded it. The sky was partially clear at the time, and the air perfectly still: the sensation produced by the tremor was very peculiar, and different from that of ordinary vibration.—J. R. Hind.

At Chelsea two clocks stopped, one on mantelpiece the other on wall. At Kew Observatory the magnets were not affected.

15. Buckinghamshire.

Place.	Sensation.	Sound.
Hemel Hempstead ..	Swaying shiver[1].	
Slough	Undulatory motion[2].	
Stoke	House rocked[3].	

[1] 3.35 A.M., slight shock felt, lasting about 15 seconds.—H. H.

[2] 3.25 A.M., severe shock felt; lasted some seconds; shook wardrobes and wash-hand-stands. The undulatory motion was from E. to W.—J. W.

[3] About 3.23 A.M., shock felt, lasting about 3 or 4 seconds. House substantially built. Not the least wind blowing at the time, and an unearthly stillness seemed to prevail for some time afterwards.—J. A. G.

16. Oxfordshire.

Woodstock............	Slightly.	

17. GLOUCESTERSHIRE.

Place.	Sensation.	Sound.
Ashchurch	Beds shaken	Passing train.—J. A.
Berkeley Road	Beds shaken	Thunder[1].
Cambridge	Bed shook like ship in heavy sea	Distant thunder[2].
Cheltenham		Confusion of sounds; roll of heavy waggon[3].
"		Rumbling; thunder.
"	Vibrations; lateral upheaval of beds	Deep rumbling; artillery-waggon moving[3].
"		Roaring noise[3].
Cirencester	Heavy article thrown on floor overhead	No sound[4].
"	House shaken; motion as if in ship's cabin	No sound[4].
Cleve	Shivering	Heavy goods-train passing slowly[5].
Clifton	Undulating movement of bed; violent jarring	Rumbling[6].
Cotswold Hills	Horizontal movement	Rumbling[7].
Dursley	Beds shaken	Rumbling.
"	Beds shaken	Heavy waggon on the road[8].
Frocester	Violent shaking	Loud rumbling.—J. A.
Gloucester		Heavily loaded waggons passing[9].
"	Strange vibration, and shaking of bed	Low roaring.
Haresfield		Gust of wind.
Lyerny	Rudely shaken; moved in bed 3 or 4 in. to E.	Heavily laden waggon at full speed striking house[10].
Mangotsfield		Sharp rattling.—J. A.
Stroud	Houses shaken	Explosion; heavy waggon hurrying past[11].
Tewkesbury		Rumbling.
"	Oscillation of bed; house swaying rapidly to and fro[12].	
Wickwar	Signalman's box much shaken	Low rumbling.—J. A.

17. Gloucestershire (*continued*).—Notes.

[1] Direction S.; pheasants and water-fowl made loud noises directly after shock.—J. A.

[2] Direction W. to E.; weather calm and warm.—J. A.

[3] Books thrown down on shelves, and pictures swung to and fro on walls, remaining awry afterwards; barometer, observed immediately after shock, exhibited considerable depression.—Rev. T. W. Webb.——Direction N.—J. A.——3.20 A.M.: more distinct and alarming than any recorded during past history of this country. Vibrations increased with height of building; fire-irons and the heaviest pieces of furniture violently agitated; beds lying E. to W. laterally upheaved. Night beautifully calm and frosty; aneroid showed no unsteadiness.—C. H. Bromby.——3.30 A.M., shock felt; lasted about 7 seconds; accompanied by roaring noise, which died away with shock. Night perfectly clear and calm.—W. R.

[4] No rumbling or rattling noise without. The whole thing was as brief and transient as a railway-train passing platform.—Robert Brewin.

3.23 A.M., smart shock felt, motion appearing to proceed from S. to N. No artificial power could have shaken the building in the manner experienced. Night clear and frosty, moon and star-light.

[5] Direction E.S.E. to W.S.W.; boatmen on Severn felt a shiver.—J. A.

[6] Sound apparently from E. to W.—Mr. Malthus.

[7] 3.25 A.M., movement lasted from 4 to 5 seconds; seemed to be in a direction from E. to W. No repetition of movement observed after shock. House situate at the commencement of the rise of the Cotswold Hills.—W. R. A.

[8] Direction N.E.——Direction N.W.; weather remarkably fine and calm; dogs howled, and cocks crowed.—J. A.

[9] Direction E. to W.; weather clear and frosty. Water in Gloucester and Berkely Canal was greatly disturbed; persons on board vessels sensibly felt shock.—J. A.

[10] Thrown from centre of bed 3 or 4 inches in an easterly direction; noise trifling; time occupied less than 2 seconds.—W. M. Thomas.

[11] Many clocks stopped.—Robert Brewin.——3.25 to 3.30 A.M.: sky brilliantly clear, faintly illuminated with the waning moon. On the day previous, about 4 to 5 P.M., heavy thunder-clouds in S., and glass sinking; but at 11.30 P.M. all had passed away, the sky being most brilliant with stars. Houses shook; crockery of wash-stands rattling, and doors of wardrobes flapping. Not severe enough to ring bells.—S.

[12] Direction S.S.W.—J. A.——3.30 A.M., basins and jugs in commotion, and staircase creaking; movement lasted some 10 or 12 seconds.—Y. Z.

Felt at Bristol; direction S.W.; weather rainy and windy: at Charfield also. At Stonehouse, direction N. to S., two distinct shocks like waves; watchman thought his box was falling to pieces.—J. A.

3.24 A.M.; shock felt, lasted 10 or 15 seconds; mercury in barometer slightly rising.—A. K.

18. Berkshire.

Place.	Sensation.	Sound.
Theale	Jarring motion and shaking of bed[1].	

[1] About 3.30 A.M., jarring motion, gradually increasing in violence till window rattled and bed shook.—F. B.

19. Surrey.

Place.	Sensation.	Sound.
Brixton	House shaken rather violently; strange lifting motion of bed[1].	
Clapham	Horizontal movement of house[2].	
Dorking	Beds violently shaken, lifted and jerked upwards.	
Frimley	Oscillation of bedstead as if on shipboard	Rumbling; explosion; thunder.
Guildford		Explosion of powder-mills.
Hill parts of W. Surrey	Horizontal oscillation; succession of bumps	Low rumbling; distant thunder; distant cannon[3].
Witley	Beds violently shaken, lifted and jerked upwards.	

[1] About 3.15 A.M., house shaken with considerable violence; the movement of the house seemed as if doors and windows had been heaved up with crow-bars.—W. P. J.

[2] 3.15 A.M., motion N. to S. and repeated from S. to N.—W. N.

[3] Whole duration did not exceed 2 seconds; rumbling very loud in the vicinity of range of hills near Haslemere (known as Hindhead Hills, Devil's Punch Bowl and Leath Hill); also on the range extending from Guildford, W., as far as Farnham, and called the Hog's Bank. Those out say, resembled distant cannon; but those in the levels say, rattling and cracking of rifles.

20. Kent.

Blackheath	Undulating movement of beds[1].	
Higham	Violent swaying and heaving of bed	No noise[2].

20. Kent (*continued*).—Notes.

[1] 3.20 A.M.: beds placed N. and S. Four very distinct shocks in the space of 2 seconds; motion was from E. to W., and felt as if four waves had succeeded each other at equal intervals under a boat. House situate on top of heath facing Surrey hills, on one side to S., and London on W. Air perfectly still, with slight frost, and moon shining brightly.—Richard Davis.

[2] 3.20 A.M.: shock lasted nearly a minute; air perfectly still, and much warmer than it had been in earlier part of night. Awakened by a violent swaying of bedstead from side to side, accompanied by a singular heaving motion, as if some great beast had been crouching asleep under the bedstead, and were now shaking itself and trying to rise. The bedstead, a large iron one, appeared to be the only piece of furniture in room that was heavily shaken. There was no noise, and neither doors nor windows rattled. House stands alone, on high ground, in neighbourhood of two great rivers.—Charles Dickens.

21. Somersetshire.

Place.	Sensation.	Sound.
Bath	Peculiar shiver of bed; bed heaved as if man under.	Low rumbling; heavy waggon passing[1].
Taunton	Violent shaking of houses and beds[2].	
„	Violent shaking of beds; thought houses about to fall[2].	
Wellington	Room shook strongly, as if part of house fallen...	Loud rushing noise.
Weston-super-Mare	....	Rumbling; high wind[3].
„	....	Rumbling; heavily laden waggon passing[3].
„	Oscillation of bed	No noise[3].
„	....	Like strong E. wind[3].

[1] Motion very peculiar; felt almost powerless; time only 3 or 4 seconds.—J. PERKIN.——Water in deep well cloudy or thick all day after the shock.—R. H. BRACKSTONE.

[2] Windows and furniture shaking violently; hundreds of sleeping inhabitants thrown into state of absolute terror; thought houses about to fall.—W. W. FIFE.——Windows of county gaol broken.——3.20 A.M.: many raised from their beds; articles of furniture thrown about.

[3] 2.30 A.M., night calm.——2.25 A.M., bells rang violently three or four times in succession. One mile N.W. on hill 90 feet above sea.——3.30 A.M., books fell on floor from book-shelf, which ran a long way due N. and S., the shelf being on W. side of wall. Bed oscillated two or three times per second; duration 3 or 4 seconds. Oscillations at right angles to plane of wall. Windows facing due E. vibrated violently for 10 seconds; three or four smart shocks from E. to W. in nearly as many seconds.—W. H. WOOD.——Similarly felt at Worle.

22. WILTSHIRE.

Place.	Sensation.	Sound.
Devizes	Horizontal and vertical movement of floor[1].	
Marlborough	Bed moved as if some one underneath[2].	
"	House shaken violently[2].	

[1] Direction of wave somewhat N.W. to S.E., as if some one trying to open door frustrated by undulating inequality of floor.—W. W. FIFE.

[2] Noise and motion did not occupy 30 seconds.—Rev. E. B. WARREN. Felt also at Rainscombe.

23. HAMPSHIRE.

Southampton	Vibration[1].	

[1] About 3.22 A.M., noise heard, as though a heavy forcible entrance was being effected by burglars, accompanied by a palpable vibration.

24. Sussex.

Place.	Sensation.	Sound.
Hurstpierpoint ……	Violent concussion; thought house falling in …	Half-dozen powder-mills blowing up simultaneously[1].
,, ……	Beds shook violently[1].	

[1] An extraordinary red line visible, notwithstanding the profound darkness of sky; dog barked furiously.—Annie R. Elwood.

25. Isle of Wight.

Osborne……………	Sensibly felt.—Mr. Mann.	

26. Dorsetshire.

Place.	Sensation.	Sound.
Abbotsbury	Foundation of house settling.—Rev. R. S. Eaton.	
Bournmouth	Bed shaken[1].	
Charmouth............	Very heavy object rolled on floor or against house.—W. W. Fife.	
Upway	Oscillating and tremulous motion of floor	Peal of thunder[2].

[1] Appeared to come from S.W., and to travel towards S.E.—W. S. Falls, M.D.

[2] About 3.0 A.M., oscillating motion, continued for a period of at least 8 seconds.—John B. Swann.——Felt at Broadwinsor, shock lasting about 2 seconds.—T. R. T.——Felt also at Dorchester and Bridport; at Poole bells rang, windows and doors violently shaken, and candlesticks and ornaments thrown down.—W. W. Fife.——Felt at Weymouth; night clear and beautiful.—W. W. Fife.

27. Devonshire (E. of Exeter).

Axminster	House and bed violently shaken[1].	
Exeter	Vibration; bed shaken..................................	Railway-train passing.
Ilfracombe............	Violent trembling and sharp shaking of bed	Loud rushing[2].
Sidmouth	Tremor.—W. W. Fife.	

[1] About 3.30 A.M.: convulsion did not continue many seconds; effects compared to efforts of a strong person shaking bedstead violently for the purpose of arousing its occupant. Bottles and glasses jingled like bells; no wind stirring.—William Pulman.

[2] 3.20 A.M.: direction of shock was from S. to N., and the disturbance appeared to be entirely lateral; no lifting-up or heaving of the earth felt. There was no wind, but some heavy black clouds were drifting slowly across from the W.N.W.; between clouds the sky was beautifully clear, and moon and stars very bright.—J. F.——Felt rather severely at Sidbury and Ottery St. Mary; and at Branscombe a ceiling was thrown drown.—W. W. Fife.

24. Sussex.

Place.	Sensation.	Sound.
Hurstpierpoint	Violent concussion; thought house falling in ...	Half-dozen powder-mills blowing up simultaneously[1].
"	Beds shook violently[1].	

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ADDENDA.

An island had been thrown up in the Mediterranean, and a shock had been felt in Antigua, at $10^h\ 30^m$ on the 5th of October (equivalent by difference of longitude to $2^h\ 28^m$ on 6th of October, in this country, allowing 55^m for the travelling of the earthquake-wave).

Bootle, Seaforth, Waterloo, Crosby (near Liverpool, Lancashire). —Shock violent.

Everton and Kirkdale (near Liverpool, Lancashire).—Had much glass broken.

Dawlish, Teignmouth, Broadclyst, Newton, Ashburton, and Bideford (Devonshire).—Persons considerably alarmed.

Tywardreath Vicarage (Cornwall). — Previous to the shock (which lasted 2 or 3 seconds) the rocking and heaving produced a peculiar sensation. The chimney and grate seemed first affected. There were also noises from the room underneath.—EDITOR OF 'WESTERN MORNING NEWS.'

Stokeclimsland, Callington (Cornwall).—Noise as of a heavy waggon passing rapidly; violent shaking of door and window, and the bed trembling.—Rev. W. C. LOVELAND.

Liskeard (Cornwall).—Vibration perceived.

Woodtown (Norfolk).—Vibration lasted 15 seconds; there was a cracking noise.—W. F. COLLIER.

Axminster (Dorsetshire).—Bottles in bedroom jingled.—Mr. PULLMAN.

Barnstaple (Devonshire).—Two bottles thrown down.—J. K. COTTON.

Ilfracombe (Devonshire).—Sharp shaking from S. to N.; bed trembled violently; loud rumbling sound.—J. F.

Alvaston, Alfreton, Matlock, Chatsworth, Brailsford, Quorndon (Derbyshire).—Shocks distinct.

Breaston (near Derby, Derbyshire).—Rocking violent, a little child lying near the edge of the bed shaken out.

Longford (Derbyshire).—Bells on shutters rang.

Derby (Derbyshire).—Sound like heavy man running across the room with bare feet, which lasted about five strides or 3 seconds. Bed rocking from E. to W. Time $3^h\ 20^m$; another shock afterwards.—R. MOSELEY.

East Retford (Notts.).—A kind of murmuring, gurgling noise resembling a singular kind of wind; gas suddenly put out as if with

a jerk, and it was difficult to relight for some time afterwards. Beds lifted, and rings of curtains shaking.—J. E. PIERCY.

Fledborough, Stoke Field, and Cromwell (near Newark, Nottingham).—Many awoke by a rumbling sound like distant thunder, accompanied by a tremor by which doors, windows, and beds were shaken.

Grantham, Knipton, and Belvoir Castle (Lincolnshire).—Earthquake felt.

Knighton (near Leicester, Leicestershire).—Two separate upheavings of the bed. Gas affected; the lighted jets flickered as if meter short of water.

Macclesfield (Cheshire).—Six vibrations in 3 seconds; undulations from S.S.E. to N.N.W.

Gnosall (Staffordshire, 7 miles W.), *Brick House* (2½ miles N.E. of Stafford).—Distinctly felt.

Betley (Staffordshire, 23 miles from Stafford).—Distinctly felt at $3^h\ 23^m$; vibrations from E. to W. Some persons had noticed a slight vibration 2 hours earlier.

Royal Observatory (Kent).—Mr. Ellis, who was observing the collimation of the wires of the altazimuth at the time of the earthquake, perceived the mark to move in so extraordinary a manner that he thought the wall to which it was attached was in motion. —ASTRONOMER ROYAL.

Wrottesley Observatory.—Mr. Hough, while observing at the time of the earthquake, felt a rocking motion in his chair.—LORD WROTTESLEY.

Helston (Cornwall).—One lady felt her bed shake, and was awoke by a noise. My daughter thought a carriage had driven rapidly into my stable-yard. Many persons were awoke by the noise.—M. P. MOYLE.

Berkhamstead, Aspley (Bedfordshire), and *Eccles* (Lancashire). —Sensibly felt.

Note.—Addition to the list of English earthquakes given in pp. 59, 60:—1761, August 14, Guernsey; 1762, March 27, Shaftesbury; 1767, January 18, Flintshire; 1768, May 15, Yorkshire; 1768, December 21, Droitwich, Gloucester, &c.; 1769, April 2, Devonshire; 1769, June 8, Dongelly; 1769, November 23, Warwickshire; 1771, April 29, Abingdon.

SUNDRY NOTES.

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18. *Meteorology in Switzerland.*—Our Swiss meteorological system has been in work since the 1st of December. Eighty-six stations are established, but it would be too much to affirm that all their observations will be equally good. It is probable that some of them will yield results of inferior worth; but these are sure to be few, and there will therefore remain a rich harvest of meteorological data. For example, one curious fact has already come to my knowledge. It is, that during December we have had days of dense fog in the Pays de Vaud, and over the basin of the Lake of Geneva. The humidity was 1·00. Now, on the same days at St. Croix, on the Jura, the humidity was 0·20. An extreme dryness existed above the fog. The latter seemed as it were to have drawn away and taken possession of the vapour of the superior atmospheric layers. The sun was brilliant, and the sky was clear, over St. Croix.

Our Federal Chambers have voted the necessary sums, and the undertaking has every chance in its favour of being continued during three years.—*Extract of a Letter from* Professor DUFOUR, *of Lausanne, to* F. GALTON, Esq., F.R.S., *Foreign Sec.*

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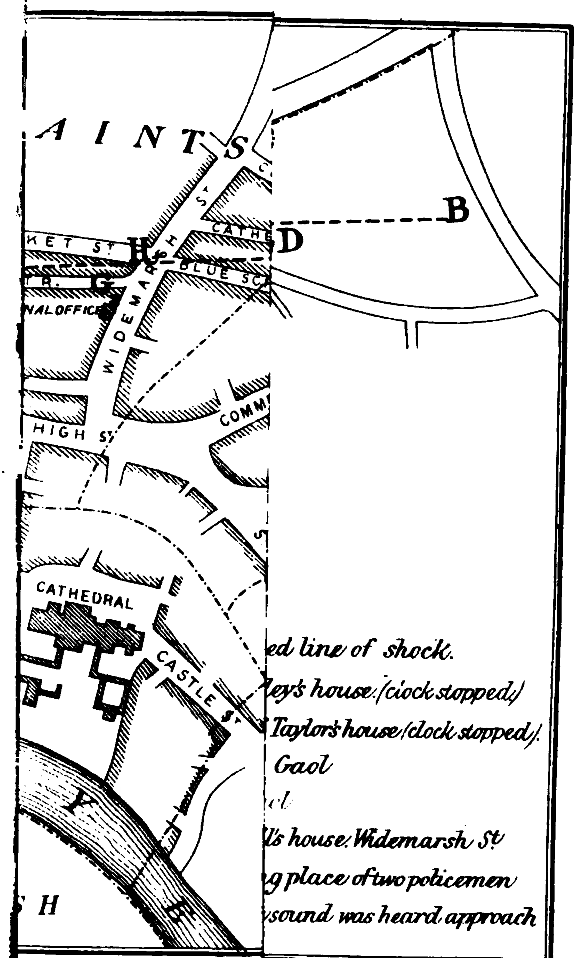
19. *Gigantic Balloon.*—We live in an age of balloonacy. Only a few weeks ago I sent you the account of M. Nadar and his 'Géant,' "the greatest balloon in the world;" now M. Eugène Godard has built an 'Aigle,' by the side of which the 'Giant' is a mere dwarf. I saw this monster in a semi-inflated state to-day in the Palais d'Industrie. It is wonderful! I went inside, and stepped thirty paces. "That is a sixth of the extent," said my conductor. 'L'Aigle' is to be inflated by smoke from straw, burned *en route*, and a supply of fuel is carried dangling from the hoop that supports the car. This is the system of "field-ballooning" introduced by M. Godard in the Italian campaign, and which I have seen used with great success. The whole 'Aigle' cost only £800. I noticed that a certain lot of soldiers were told off to assist M. Godard in his work. The Emperor takes great interest in the matter. To-morrow the Government Commissioners will report on the "air-worthiness" of the new balloon, and on Sunday week it will ascend for the first time. If, as its constructor fully believes, the ascent prove successful, he will build really a large balloon, which can carry up a company of Chasseurs d'Afrique, who will be able to rake their enemy from the sky, and take "pot shots" from behind a thick cloud.—1864, February 20, *Daily Telegraph.*

PLATE XXI.



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ley's house (clock stopped)
Taylor's house (clock stopped).
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g place of two policemen
sound was heard approach

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

VOL. II.] 1864, FEBRUARY 17. [No. 11.

R. DUNDAS THOMSON, Esq., M.D., F.R.S. L. & E.,
President, in the Chair.

William Blundell, Esq., M.R.C.S., 41 Sloane Square, Chelsea, S.W.;
Thomas Challis, Esq., Wilton House, Salisbury, Wiltshire;
Dr. F. Churchill, jun., 15 St. Stephen's Green, Dublin; and Simmons Town, Cape of Good Hope;
Sir Daniel Cooper, Bart., 20 Princes Gardens, Hyde Park, W.;
John William Eccles, Esq., 8 King's Bench Walk, Temple, E.C.;
Frederick Gaster, Esq., Meteorological Department, Board of Trade, Whitehall, S.W.;
Wm. Rankin, Esq., M.D., Otter House, Argyleshire;
Clarence Edward Trotter, 1 Somerset Terrace, Carlton Road, Maida Vale, W.;
Malcolm McNeal Walker, Esq., 38 Clyde Place, Glasgow;
were balloted for and duly elected Members of the Society.

The names of Two Candidates for admission into the Society were read.

The following gentlemen, who had been duly elected Members, subscribed the Form No. 2, and were admitted into the Society:—

	Elected
Henry Deane, Esq.	1863, November 18.
Henry Deane, jun., Esq. (by proxy)	1863, November 18.
C. F. Kierzkowski, Esq.	1864, January 30.
N. Whitley, Esq.	1864, February 18.

LIII. *Sound in the Upper Air, while the Lower Air was still.* By Alex. Herschel, Esq. Communicated by Henry Storks Eaton, Esq., M.A., Librarian.

I hope the enclosed letters to the daily papers received your attention, as I am satisfied there are some points contained in them little understood. On the 29th of August last, being nearly full moon, I went out to note the weather at 9 o'clock P.M., and found the moon in an interval of pure sky, surrounded by very stormy clouds. At the same time I think there must have been a rapidly driving scud underneath the moon, and in other parts of the sky; for I listened without concern to what I conceived to be the roaring of the wind in the fir trees at the N. of my station. The sky in the N. was dense with black clouds to the horizon. After some minutes' examination, it occurred to me that the air was quite placid, and that no wind was stirring; I therefore walked to the clump of fir trees in the N., and found them quite silent; but the noise was still continuing in the N. There were some more fir trees in that direction, and I therefore continued the walk, about 200 yards, until these fir trees were also left behind me, and an open common extended northward, without any obstacle, to a hill at the distance of a mile, on whose summit is a village. The noise appeared to be brooding over the village. It resembled the noise of the spinning-mills which can be heard in some of the streets of Leeds. I had heard of the rushing of air-strata past each other; but could not reconcile so loud a noise with such an explanation, and thought that it must have been an enormous downpour of rain upon the slate roofs of the village and in the valley beyond the hill. A single flash of lightning, exceedingly bright and (if I recollect rightly) unaccompanied by thunder, confirmed this impression; but two days after, being on a shooting-party at a spot four or five miles N. of the village on the hill, I found indeed that much rain had taken place, but that, at the very hour when I heard the continued roaring noise, an observation of a lunar rainbow was made (at 9^h 15^m P.M.) by a gentleman who did not know that at this time any great quantity of rain had fallen. He went out to examine the weather at 9^h 15^m P.M., and did not know that there had been a storm of lightning. I may add that I could not watch this peculiarity long, as rain caught me on the common; and I returned. In twenty minutes after I first went out there was a drenching fall of rain, but quite vertical. *No wind.* On recalling to mind the nature of the noise since its

occurrence, I cannot think that any fall of rain at the distance of *at least a mile* could have made such an awe-inspiring noise. It lasted, while I attended to it, about ten minutes.

I noted the sky on the evening of the 21st of January, when Mr. Brett wrote a second letter to the 'Morning Herald,' of which I have no copy. He heard "leafy rustling" among the driving clouds. I can only say that in perfect stillness and calmness, from 9^h to $10^h 30^m$ P.M., I heard none; but the various motions of the clouds under the moonlight were extraordinary. Although there was *no wind* upon the ground, a low scud was flying at a furious speed from W.S.W.; but aloft the clouds had a *very slow* motion from N.N.W., which it was very difficult to assign determinately, as stationary moments were apt to occur, as if the clouds retreated on their former course and resisted the advance of the rest. I noted this and other convolutions among the high clouds by comparing them with the stars, which were clear and well seen in the intervals.

The following are the letters to which reference is made:—

"I partly expected to see in your issue of to-day some notice from your correspondents of a curious phenomenon, that took place about Saturday (16th January) at midnight. This was a loud and continuous noise in the air, apparently coming from the S. or S.W., and accompanied with a sound resembling that made by a heavy luggage-train a short distance away, or the sound of a large waterfall. It lasted from about $11^h 45^m$ till about 2^h, so far as I know; for I went to bed at the latter hour, and there was no intermission during that time. The air was perfectly still, except now and then fitful gusts. There was no rain, but the sky was overcast. My idea was that it was a great storm of wind overhead, a mass of quiet air lying between us and it. Perhaps some of your readers may have noticed the same thing in other parts of the country. The policemen and others, spoken to whilst it was going on, all declared it was a luggage-train, until undeceived by its continuing so long."—AUSCULTATOR, *Cheltenham*, January 19th, 1861.—*Morning Herald*, Thursday, January 21st, 1864.

"The phenomenon described by your Cheltenham correspondent, as having occurred at and from midnight of Saturday, and continuing for some hours, resembling the noise made by a heavy luggage-train, &c., was distinctly heard in this locality, and was commented upon

at the time, as being something unusual. The unusually hollow and continuous noise of this supposed storm induced me to go out, with the intention of ascertaining whether the roar proceeded from above or below, the sound being not much unlike that sometimes produced by the action of the sea, which our fishermen tell us is the precursor of a gale. I soon convinced myself that this was not the case, but that the noise came from overhead. On the night of Tuesday, the 19th inst., there was even a greater manifestation of the phenomenon than on that of the previous Saturday, the 16th. There was, in fact, a perfect roar in the upper air, from near midnight until 2^h to 3^h A.M.; so much so indeed that, knowing how much unlikely it was to be caused by the merely fresh breezes then blowing on land from the S.W., it excited my curiosity and that of my wife to such a degree as prevented our sleeping. I ultimately discovered that there was violent commotion in the air at a considerable elevation, masses of nimbi being seen to pass under the moon with desperate velocity. The next daybreak found us enveloped in a cold, drizzling, driving fog, since which we have had squally and unsettled weather."—T. B. BRETT, *St. Leonard's-on-Sea*, January 21st. —*Morning Herald*, Saturday, January 23rd, 1864.

"The interesting and peculiar phenomenon observed by 'Auscultator,' at Cheltenham, and Mr. Brett, at St. Leonard's, are but a more distinct state of disturbance, though of the same nature as we have experienced at intervals since the beginning of the month. On the night of the 19th, during a heavy fall of rain, I heard a sound as of a distant storm. Being thereby induced to look out, I found everything in a comparatively quiescent state; but the noise continued for upwards of half an hour. That the same should have occurred at distant places at the same time is in itself remarkable."—METEOROLOGIST, *Chepstow*, January 23rd, 1864.—*Morning Herald*, Tuesday, January 26th, 1864.

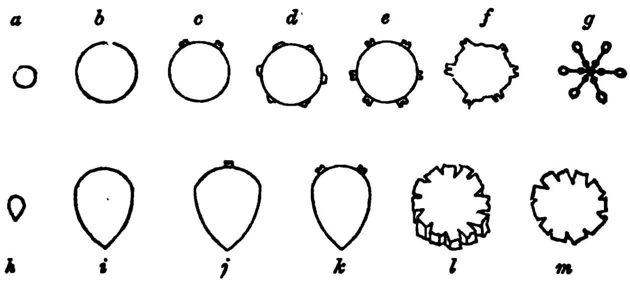
LIV. *Snow-Crystals and Hail as observed at the Beeston Observatory.* By E. J. Lowe, Esq., F.R.A.S. &c.

On Sunday, January 3, after severe frost with cloudless sky, the wind moved from N.W. at $6^h 55^m$ A.M. to E.N.E., becoming E.S.E. at $9^h 27^m$, E. at $10^h 30^m$; and at $10^h 35^m$ A.M. snow and hail commenced falling together, both small in size, at first more hail than snow; yet the peculiar feature of this shower was a gradual transition from snow-crystals to hail. At 11 o'clock it became fair, the amount of snow and hail fallen being not sufficient to whiten the grass, although the gravel paths were white.

The transition from snow to hail will be apparent by reference to the diagrams, both in the circular hailstones and in those which were more or less conical.

Nearly two-thirds of them were somewhat conical-shaped hailstones, as *i*, the size being only equal to *h*, fig. 7.

Fig. 7. *Hailstones seen at the Beeston Observatory.*



One-third of the snow-flakes were lozenge-shaped, flat but thick, like *l*.

About a tenth part of the hailstones were circular, but indented, like *m*.

In abundance they followed the following order:—*i*, *l*, *e*, *m*, *b*, *f*, *d*, *k*, *c*, *j*, *g*.

There were so many examples of each to put under the magnifier, that the transition was quite apparent.

It is somewhat singular that the tendency of the hailstones to assume the hexagonal form occurs both as appendages and as indentations.

For many years I have carefully examined the snow-crystals, and even seen their formation and development, yet never saw any approach to this form in hailstones until this shower.

The temperature of the air at the time was 30°·7, and of the

wet-bulb 29°·9; it had been as low as 27°·1 in the night, and again fell all day till it reached 22° at 9 P.M. The barometer, corrected and reduced to the sea-level, was 30·69 inches, and at 10 P.M. had reached 30·72.

The following Table will show the great cold that followed:—

	Greatest Heat.	Greatest Cold.	Minimum on grass.	Adopted mean Temperature.
	°	°	°	°
January 1...	36·5	29·7	24·7	33·3
2...	36·2	25·8	15·2	30·8
3...	33·0	22·0	14·3	27·6
4...	31·5	21·1	12·3	26·0
5...	31·6	21·5	14·2	26·2
6...	25·0	12·5	4·0	18·0
7...	27·0	7·7	1·0	19·1
8...	29·0	17·7	5·8	25·4
9...	35·2	23·1	16·0	32·5
10...	42·2	33·0	26·2	37·2
11...	47·5	38·3	31·8	41·8
12...	40·8	33·0	35·0	37·1

After the 1st there was no ozone till the 19th, except a faint trace on the 2nd, 12th, and 17th. From the 19th to the end of the month the amount was considerable.

Mean amount from 2nd to 16th =0·1
" " 17th to 31st =5·0

Wind-changes, from the 'Atmospheric Recorder.'

	d	h m		
December...	30			S.W.
		7 1 P.M.	moved through S. to	E.N.E.
January ...	2	noon		N.N.E.
		1 23 P.M.		E.
		8 33 P.M.		N.N.E.
		9 23 P.M.		N. by W.
		10 13 P.M.		N.W.
	3	6 55 A.M.		E.N.E.
			oscillating from E.S.E. to	E.N.E.
	4	8 40 P.M.		N.
	5	6 45 A.M.		N.N.E.
		7 45 A.M.		N.E.
		8 5 A.M.		E.N.E.
		2 50 P.M.		N.E.
			oscillating between N.E. and	N.

Wind-changes (*continued*).

	d	h	m		
January ...	6	9	44 A.M.	....	W.N.W.
		11	28 A.M.	....	S.W.
	7	6	1 P.M.	....	W.
		11	25 P.M.	moved through N. to	E.N.E.
	8	8	10 A.M.	„ „ „	N.N.W.
		1	50 P.M.	....	W.S.W.
	9	12	55 A.M.	....	S.S.W.
		8	41 A.M.	moved through S. to	E.
		8	59 A.M.	....	E.N.E.
		11	50 A.M.	....	E.S.E.
		12	18 P.M.	....	S.S.E.
		1	23 P.M.	....	S.E.
		2	43 P.M.	....	E.N.E.
	10	10	38 A.M.	....	E.
		12	23 P.M.	....	S.S.E.
		1	51 P.M.	....	E.S.E.
		4	41 P.M.	....	S.S.E.
	11	5	31 A.M.	....	S.E.
		6	56 A.M.	....	E.
		7	50 A.M.	....	S.S.E.
		10	25 A.M.	....	E.S.E.
		3	15 P.M.	....	S.
		4	5 P.M.	....	S.E.
		5	26 P.M.	....	E.S.E.
		6	26 P.M.	....	S.E.
	12	7	10 A.M.	....	S.S.E.
		3	40 P.M.	....	S.
		4	39 P.M.	....	S.S.W.
		9	40 P.M.	....	W.

The time indicates the moment of the change.

LV. *Ozone-Observations in Finland.*

By E. H. JULIN. Communicated by L. P. CASELLA, Esq.

(Abstract.)

THE author submitted some ozone-papers, that had been exposed at Helsingfors, in Finland, close to the Baltic, and which had been obtained for him and forwarded by Mr. Casella. His letter is dated 1864, January 19, and the paper had been exposed since

the cold weather had set in; but he had not made any previous observations from which he might have determined whether the ozone increased in quantity, as he seemed to anticipate, with the cold. The winter had previously been unusually mild, with hardly any snow; the temperature had been steady and equable. The papers submitted were discoloured; but there was no definite character in them from which any conclusions could be drawn.

He had exposed ozone-paper, with no result, at Aix-la-Chapelle. The sulphur-waters there impregnate the whole town. The smell of the drains there is without parallel. Both there and at Helsingfors he had exposed the papers outside a window, and not in free air, in the absence of a more fitting place. Mr. Casella will furnish him with paper and full instructions for future observations.

LVI. *On the Storms at the close of October* 1863. By Henry Storks Eaton, Esq., M.A., Librarian.

At the end of October and beginning of November 1863, a series of storms traversed the northern parts of Europe, entailing many disasters by sea and land. The occasion proved a favourable one for examining the rate of progress and direction in which these storms advanced, as they presented a fair type of our more severe autumnal storms.

In accordance with a wish expressed at the Meeting of this Society in November, I now bring forward some particulars relating to the subject.

The weather, which had been rainy in Great Britain during the previous part of October, cleared up about the 20th, and on the evening of the 23rd the barometer attained a height of 30·3 in.* From this date it gradually fell, the wave of high barometer advancing eastward. The weather continued fine; light variable breezes prevailed till the 28th, when rain came on, with a westerly wind, and on the 29th the calm weather was broken by the irruption of a tempest from the Atlantic.

The gradual diminution of the atmospheric pressure in the west of Europe during this interval, while it increased in the east, and the tendency of the wind to blow from the region of the higher

* Reduced to sea-level, as are also all subsequent readings of the barometer.

pressure to the lower—a tendency pointed out by Mr. Galton in his 'Meteographica'—are well shown in Leverrier's "Bulletins of Weather," published daily in Paris. The following brief description of the weather, from October the 23rd to the 28th, is an abstract of the valuable information they contain.

Barometer.		inches.	Wind and Weather.
October 23.	Haparanda, at the top of the Gulf of Bothnia	29·47	In the Baltic, brisk wind from S.W. Elsewhere nearly calm. Rather foggy in the north; fine in the south of Europe.
	South Britain	30·30	
	North of Scotland	30·15	
	Naples	29·92	
	Algiers	30·24	
October 24.	St. Petersburg	29·51	Easterly and light in France. Southerly in the West of England and Ireland.
	Brussels	30·33	
	England	30·20	
	South of Europe	30·00	Fine: somewhat cloudy in England.
	Algiers	30·22	
October 25.	Copenhagen and Leipzig	30·33	Light breezes from east, in Portugal from the south. Fine. A little rain in the south of Spain.
	Moscow	30·25	
	Greenwich	30·06	
	South of Europe	30·08	
	to	30·00	
	Portugal	29·87	
October 26.	Leipzig	30·32	Calm, or a breeze from east in Central Europe, from south in the north of Europe, from north in Italy. Weather very variable, cloudy and foggy in several places.
	St. Petersburg	29·95	
	England	30·10	
	South of Europe	30·05	
	Portugal	29·78	
October 27.	Moscow	30·31	In North Europe light breezes from west and south-west; from the east in the Centre and South. Fine, but more cloudy than before.
	Haparanda	29·94	
	England	30·00	
	West of Ireland and North of Scotland	29·88	
	South of Europe	30·10	
	to	30·00	
	Lisbon	29·83	
October 28.	St. Petersburg	30·31	Light southerly and easterly on the Continent. South-west to north-west in Great Britain, and light. Rainy in Spain and parts of Great Britain; cloudy elsewhere.
	North of Scotland	29·50	
	South of England	29·68	
	Central Europe and Italy	30·00	
	France and Spain	29·80	

The general features of the weather on the following days are indicated at greater length in the following Table (Table I.), which I have converted from French into English values.

TABLE I.

October 29th, 1863.

	Barometer.	Temperature of the air.	Direction of the wind.	Force of the wind.	Weather.
	inches.	°			
Dunkirk	29·61	44	S.W.	Light	Cloudy.
Mezières	29·76	....	S.E.	Light	Overcast.
Strasbourg	....	49	S.	Nearly calm	Rain.
Paris	29·70	47	S.	Light	Overcast.
Le Havre	29·64	53	S.W.	Brisk	Overcast.
Cherbourg	29·54	50	W.S.W.	Light	Overcast, rainy.
Brest	29·51	55	S.W.	Light	Overcast.
L'Orient	29·60	55	S.S.W.	Strong	Overcast.
Napoléon Vendée	29·74	49	S.	Nearly calm	Overcast.
Rochefort	29·76	52	S.	Brisk breeze	Rainy.
Limoges	29·78	57	W.	Nearly calm	Overcast.
Montauban	29·85	59	S.	Light	Cloudy.
Marseilles	29·86	60	S.E.	Brisk	Rainy.
Toulon	29·88	61	E.N.E.	Brisk	Rainy.
Avignon	....	56	N.	Nearly calm	Overcast.
Lyons	29·85	58	S.	Light	Cloudy.
Besançon	29·84	58	S.W.	Nearly calm	Cloudy.
Bayonne	29·73	59	E.	Nearly calm	Blue sky.
Montpellier	29·87	57	N.	Light	Overcast.
St. Petersburg	30·33	31	S.	Brisk	Cloudy.
Revel	30·22	33	S.	Brisk	Clear.
Riga	30·21	29	S.E.	Brisk.	
Helsingfors	30·12	38	S.E.	Brisk	Overcast.
Moscow	30·45	31	....	Calm	Overcast.
Kiew	30·28	43	N.E.	Light	Clear.
Vienna	30·02	37	E.S.E.	Light	Cloudy.
Leipzig	29·83	39	S.S.E.	Brisk	Fine.
The Helder	29·59	47	S.	Nearly calm	Densely overcast, foggy.
Copenhagen	29·66	44	S.S.E.	Nearly calm	Dull, cloudy.
Groningen	29·61	45	S.	Nearly calm	Overcast.
Brussels	29·70	49	S.	Brisk	Overcast, misty.
Barcelona	29·81	66	N.	Nearly calm	Foggy.
Turin	30·08	52	W.	....	Cloudy.
Ancona	29·82	58	S.E.	Light	Fine.
Leghorn	29·98	54	E.N.E.	Light	Heavy rain.
Rome	30·06	56	E.	Nearly calm	Very cloudy.
Bilbao	29·81	60	E.	Light	Overcast.
Madrid	29·93	51	N.N.W.	Light	Cloudy.
San Fernando	29·86	57	E.N.E.	Nearly calm	Almost cloudless.
Palma	29·84	69	....	Calm	Some clouds.
Lisbon	29·94	61	N.	Light	Partially cloudy.
Oporto	29·95	59	N.N.W.	Light	Overcast.
Alicante	29·87	65	....	Calm	Some clouds.
Constantinople	30·18	44	W.	Light	Overcast, rain.
Naples	30·05	56	W.	Light	Foggy.
Palermo	30·02	65	W.S.W.	Nearly calm	Cirrus.
Algiers	29·95	71	E.	Light	Small clouds.
Nairn	29·25	37	E.N.E.	Very light	Densely clouded.
Greencastle	28·96	44	S.E.	Strong	Very cloudy, rainy
Galway	28·56	51	S.S.W.	Strong	Cloudy, rainy.
Queenstown	28·99	51	S.W.	Strong	Cloudy.
Scarborough	29·40	42	S.E.	Light	Overcast.
Penzance	29·35	52	S.W.	Strong	Nearly overcast.

TABLE I. (*continued*).

October 30th, 1868.

	Baro-meter.	Tempera-ture of the air.	Direction of the wind.	Force of the wind.	Weather.
	inches.	°			
Dunkirk	29·64	48	S.W.	Light	Overcast.
Mezières	29·76	....	W.	Light	Overcast.
Strasbourg	29·86	54	S.W.	Nearly calm	Overcast, rainy.
Paris	29·75	48	S.S.W.	Moderate	Almost overcast.
Le Havre	29·68	50	W.S.W.	Strong	Overcast.
Cherbourg	29·54	53	S.S.W.	Strong	Very cloudy.
Brest	29·68	53	S.S.W.	Brisk	Overcast, rainy.
L'Orient	29·66	55	S.W.	Strong	Rainy.
Napoléon Vendée	29·78	53	W.S.W.	Nearly calm	Rain.
Rochefort	29·80	55	S.W.	Moderate	Rainy.
Limoges	29·87	57	S.	Nearly calm	Overcast.
Montauban	29·92	55	S.	Light	Overcast.
Montpellier	29·97	59	N.	Light	Fine.
Marseilles	29·98	62	E.S.E.	Brisk	Cloudy.
Toulon	30·00	63	E.N.E.	Light	Foggy.
Lyons	29·95	61	S.	Light	Overcast.
Besançon	29·94	60	S.W.	Light	Overcast.
St. Petersburg	29·54	26	S.E.	Brisk	Clear.
Riga	30·00	31	S.E.	Brisk	Clear.
Helsingfors	29·87	38	S.S.E.	Light	Cloudy.
Libau	29·74	40	S.S.E.	Strong	Cloudy.
Haparanda	29·59	....	S.	Brisk.	
Moscow	30·47	29	....	Calm	Overcast.
Kiew	30·29	18	N.E.	Light	Clear.
Vienna	29·99	44	....	Calm	Overcast.
Leipzig	29·81	50	S.	Brisk	Rainy.
Stockholm	29·54	47	S.	Brisk	Overcast, rain.
Copenhagen	29·50	50	S.S.W.	Brisk	Rain, squalls of wind in the night.
The Helder	29·53	50	S.W.	Light	Cloudy.
Groningen	29·57	45	S.	Light	Cloudy.
Brussels	29·69	50	S.S.W.	Brisk	Overcast.
Barcelona	29·96	64	S.W.	Strong	Nearly clear.
Turin	30·08	50	E.	....	Cloudy.
Ancona	29·84	60	W.	Light	Foggy.
Leghorn	30·03	65	S.S.E.	Brisk	Hazy.
Rome	30·11	59	E.	Light	Slightly cloudy.
Bilbao	29·85	64	S.E.	Light	Some clouds.
Madrid	30·12	50	S.	Light	Foggy.
Lisbon	30·12	58	S.E.	Nearly calm	Foggy.
Palma	30·06	68	....	Calm	Clear.
San Fernando	30·08	62	S.E.	Nearly calm	Slightly cloudy.
Florence	30·07	63	S.E.	Light	Overcast.
Alicante	30·06	64	....	Calm	Clear.
Constantinople	30·43	52	N.	Light	Overcast.
Naples	30·12	58	S.W.	Light	Rain.
Palermo	30·07	69	S.W.	Brisk	Cumulus.
Nairn	28·79	35	S.S.W.	Fresh	Nearly overcast.
Scarborough	29·23	41	S.S.W.	Fresh	Rainy.
Penzance	29·35	51	S.S.W.	Strong	Rainy.

TABLE I. (*continued*).

October 31st, 1863.

	Barometer.	Temperature of the air.	Direction of the wind.	Force of the wind.	Weather.
	inches.	°			
Dunkirk	29·61	47	W.S.W.	Gale	Densely overcast.
Mezières	29·87	....	W.	Brisk	Overcast.
Strasbourg	29·97	50	S.W.	Light	Overcast.
Paris	29·87	44	S.W.	Light	Overcast to the N.
Le Havre	29·80	50	W.	Gale	Overcast.
Cherbourg	29·71	50	W.S.W.	Gale	Cloudy.
Brest	29·84	49	W.	Light	Very cloudy.
L'Orient	29·88	50	W.	Brisk	Overcast.
Napoléon Vendée	29·98	49	W.N.W.	Nearly calm	Overcast.
Rochefort	29·96	54	W.	Brisk	Overcast.
Limoges	29·99	49	N.W.	Nearly calm	Rain.
Montauban	30·00	57	S.	Light	Cloudy.
Bayonne	29·96	63	N.	Very light	Overcast.
Montpellier	30·04	62	N.N.E.	Light	Overcast.
Marseilles	30·03	62	E.	Light	Cloudy.
Toulon	30·04	66	S.W.	Light	Overcast.
Lyons	29·99	62	N.W.	Light	Misty.
Besançon	29·97	50	W.	Nearly calm	Rain.
St. Petersburg	29·84	30	S.	Strong	Cloudy.
Riga	29·61	38	S.E.	Strong	Overcast.
Helsingfors	29·45	41	S.S.E.	Gale	Overcast, rain in the night.
Libau	29·28	46	S.	Brisk	Rain.
Moscow	30·46	24	E.	Brisk	Clear.
Nicolaieff	30·26	32	N.E.	Light	Clear.
Vienna	30·13	45	....	Calm	Foggy.
Leipzig	29·79	46	S.S.W.	Strong	Rainy.
Copenhagen	29·21	44	S.W.	Gale	Changeable.
The Helder	29·38	48	W.S.W.	....	Very cloudy.
Groningen	29·42	45	S.	Light	Cloudy.
Brussels	29·73	53	S.W.	Strong	Cloudy.
Barcelona	30·01	65	N.W.	Brisk	Clear.
Turin	30·03	45	N.E.	....	Foggy.
Ancona	29·78	68	S.W.	Light	Overcast.
Leghorn	30·08	67	S.	Light	Hazy.
Rome	30·17	61	S.	Nearly calm	Slightly cloudy.
Bilbao	30·04	56	N.W.	Light	Overcast, drizzle.
Madrid	30·19	48	N.W.	Light	Foggy.
Lisbon	30·19	61	S.S.W.	Nearly calm	Cloudy.
Oporto	30·13	61	S.	Light	Overcast.
Palma	30·13	70	E.N.E.	Light	Clear.
San Fernando	30·16	59	N.E.	Nearly calm	Slightly cloudy.
Florence	30·10	64	S.	Light	Nearly overcast.
Alicante	30·13	65	S.	....	Clear.
Naples	30·22	54	S.W.	Light	Foggy.
Palermo	30·13	67	S.W.	Faint breeze	Foggy.
Nairn	28·64	39	S S.W.	Moderate	Rather cloudy.
Scarborough	29·03	44	S.W.	Strong	Very cloudy.
Penzance	29·67	46	W.	Strong	Cloudy.

We learn from the above that the area of low barometer and rainy weather gradually extended in an eastward direction over the whole of the north of Europe, and that meanwhile the pressure increased in the south.

Thus, the barometrical readings were as follows at the under-mentioned stations which have been selected to show this feature in the most marked manner:—

In the North.—Barometer at 8 A.M.

October	Nairn. ins.	Copenhagen. ins.	St. Petersburg. ins.	Moscow. ins.
29th	29·25	29·66	30·33	30·45.
30th	28·79	29·50	29·54	30·47.
31st	28·64	29·21	29·84	30·46.

In the South.

October.	San Fernando. ins.	Rome. ins.	Naples. ins.	Constantinople. ins.
29th	29·86	30·06	30·05	30·18.
30th	30·08	30·11	30·12	30·43.
31st	30·16	30·17	30·22.	

On the 29th, Great Britain and the north of France were involved in a storm setting in at S.E., and veering to S.W. and W.; on the following day the Baltic had begun to experience the effects of the disturbance, the wind in like manner commencing from S.E. and S., and in Great Britain veering from S. to W.; and on the 31st the direction was from W. in Great Britain, S.E. in Russia, and W.S.W. in the Baltic. On these three days the continent of Europe, south of latitude 45°, experienced on the whole fine weather and light variable winds.

There is nothing particular to remark about the temperature in this period; it was slightly above the average in the S. of Europe, and of its normal value in the N. and E.

Having thus briefly described the general characteristics of the weather over Europe at large, we will now consider the storm as it occurred in Great Britain at greater length.

At 9 A.M. on October 29, a storm, resembling a cyclone in many points, prevailed over Ireland and the southern and western parts of England. The barometrical minimum, which is assumed to be the centre of the storm, seems to have arrived from the Atlantic at the north-west coast of Ireland; in the vicinity of the centre the wind was blowing a storm from S.W. at Galway, E.S.E. at Armagh, and S.E. at Leckpatrick, near Strabane; the

precise position of the centre was probably not far from Killala in Mayo, in lat. 54° 15′ N., long. 9° W. Proceeding in a direction E. 41° N. at an average rate of thirty-three miles an hour, the centre reached Banff, on the N.E. coast of Scotland, at 9 P.M., and we perceive its influence in producing a violent tempest from W. at Sandwick between 1.30 A.M. and 4 A.M. on the 30th.

Direction and Velocity of the Wind.—I am indebted to G. B. Airy, Esq., Astronomer Royal, of the Greenwich Observatory, to the Rev. Dr. Robinson, of the Armagh Observatory, to the Rev. R. Main, of the Radcliffe Observatory, Oxford, to C. J. Woodward, Esq., of the Birmingham and Midland Institute, to J. Hartnup, Esq., of the Liverpool Observatory, to R. Grant, Esq., of the Glasgow Observatory, and to the Rev. C. Clouston, of Sandwick, Orkney, for the results of their self-recording anemometers; these, together with the frequent observations of E. J. Lowe, Esq., at Highfield House, Nottingham, the Rev. C. Maxwell at Leckpatrick, and A. Forbes, Esq., at Culloden, leave little further to be desired on this head.

The hourly records at Armagh show that the wind was light from N.W. on the 28th, and that at 10 A.M. the direction began to retrograde steadily; at 1 A.M. on the 29th, it blew pretty briskly from S., and at 8 A.M. from E.S.E.; the gale commenced at this hour, and soon after the wind began to veer with a direct motion through S. The minimum barometrical pressure occurred at 11.58 A.M., the wind being S.W. The greatest velocity of the wind was 57 miles in the hour ending 2 P.M.; the wind was then W. by S.; it became W. at 8 P.M., and, moderating in force again, retrograded to S.W. Armagh was about 78 miles on the right of the axis-path of the storm.

At Leckpatrick, only 27 miles on the right of the axis-path, the gale blew steadily from S.E. till noon, then after a lull for an hour recommenced at S.S.W., and finally reached N.W. at 11 P.M.

At Oxford, 357 miles from the axis-path, the wind retrograded from W. by N. at 4 P.M., on the 28th, to S.E. at 4 A.M., on the 29th, and continued from S.E. and S.S.E. till 10 A.M.; the gale then commenced from S.S.W., but changed to S. at 8 P.M.

At Birmingham, 307 miles right of the axis-path, the wind was S.S.E. early in the morning of the 28th; it was from S. at 9 A.M., W.S.W. at 11.30 A.M., remaining about this point till 6.20 P.M., became N.W. at 6.40 P.M., suddenly shifted through N. to E. by S. at 0.30 A.M. on the 29th; at 7.30 A.M. the wind was S., at 5.50 P.M. W.S.W., and subsequently about S.W. by W. the rest of the

evening. There was a brisk breeze between 6.30 A.M. and 5.30 P.M. on the 28th, the maximum force, 4 lbs. on the square foot, occurring at 0.30 P.M. On the 29th a gale blew from 8 A.M. till midnight, the maximum pressure, 17 lbs. on the square foot, occurring at 3.30 P.M.

At Liverpool, 226 miles from the central track, the wind in like manner retrograded, and was S.E. by E. at 9 A.M. on the 29th; at 10 A.M. it freshened considerably, and, veering gradually through S., settled in the W.S.W. at 7 P.M. The lowest barometrical pressure was coincident with the wind from S.S.W. at 2 P.M.; and the gale was at its height between 6 P.M. and 8 P.M., a pressure of 19 lbs. on the square foot being more than once recorded.

At Greenwich, 410 miles from the central path, the wind was W. at 3 P.M. on the 28th; it retrograded to S. by E. at 6 A.M. on the 29th, then returning through the S., rather suddenly shifted from S.W. by S. to W.S.W. at 3.50 P.M., in a squall having a pressure of 13·8 lbs. on the square foot, whereas at no other time between 11 A.M. and midnight, while the air was most disturbed, did the pressure amount to 5 lbs.; the lowest reading of the barometer occurred very soon after, and the wind remained steady from W.S.W. the rest of the day, save from 5 P.M. to 6 P.M., when it was W. by S.

At Nottingham, 304 miles on the right of the axis-path, the air was calm and foggy, in the early morning of the 29th; at 6.15 A.M. the fog cleared off, and rain fell for some time; at 8.22 A.M. the vane moved from W. to S., and to S.S.E. at 11.42 A.M.; it then gradually veered to S.W. by 5 P.M., and so continued. The wind increased to a gale, during a heavy shower of rain, between 1 P.M. and 2 P.M., and blew hardest between 3 P.M. and 5 P.M.; the maximum pressure, 8·5 lbs. on the square foot, was at 3.25 P.M.

At Glasgow, 45 miles from the centre, the anemometer was deranged by the violence of the storm. It appears that the wind began to rise about 3.30 A.M. on the 29th, attaining a pressure of 3 lbs. on the square foot at 8 A.M., 5 lbs. at 10.25 A.M., 11 lbs. at 0.50 P.M., and 13 lbs. at 4.25 P.M.; shortly afterwards the recording pencil was thrown out of gear; but at 8.5 P.M. the pressure was 31 lbs. on the square foot, at 9 P.M. 23 lbs., diminishing to 12 lbs. at 11 P.M., and 3 lbs. at midnight. The force of the wind was estimated to be greatest about 7.30 P.M., when it might have amounted to a pressure of 35 lbs. on the square foot.

Culloden was situated on the left hand of the storm-track, and about 33 miles from it. Although so near the centre, the wind does

not appear to have attained any great force in this particular phase of the storm. It was light from S.E. in the morning, became gusty with showers in the afternoon, fell nearly calm at 6 P.M., was E.N.E., but nearly calm, at 7 P.M.; at 7.15 P.M. the minimum barometrical reading was attained, the calm still continuing with heavy rain; between 8 P.M. and 9 P.M. a stormy wind rose from W.S.W., the direction having previously changed through S.E. and S. to S.W.; this at 10 P.M. settled in W.; at 11 P.M. the force of the wind, by estimation, was 9 lbs. to 12 lbs. pressure on the square foot.

From Sandwick, in Orkney, Mr. Clouston writes that it was calm on the 28th till 1 P.M.; then till 2 A.M. on the 29th the wind was W., very light; "2 A.M. till 3 A.M., N.W., N., N.E., and E.; 3 A.M. till 6 A.M., gone to S.E., light; remained so, with two sudden changes southward, till 11 P.M., moderate; 11 till 12 night, calm: 30th, 0.30 A.M., went to S.W., light; 1 A.M., nearly W., moderate; 1.30 till 2.30 A.M., W., a storm going 37 miles in the last half hour, when the anemometer was blown down; but I am informed that it began to moderate about 4 A.M., veering gradually southwards, where it remained, finally decreasing to a dead calm at 2 A.M. on the 31st." The minimum barometrical pressure occurred a short time previous to the storm setting in from the W. Sandwick is assumed to have been 100 miles on the left of the axis-path of the storm.

Nearly all these observations are from self-recording instruments, the rest being made by skilful observers; they therefore demand our full confidence. It is specially worthy of note that neither at Sandwick nor Culloden did the wind veer against the sun, although both these places were on the left hand of the storm-path; therefore this tempest was not a true cyclone. Mr. Forbes writes, "In regard to your query about the change of wind after the calm at 7 P.M. of the day alluded to, I am enabled to say that the wind veered with the apparent course of the sun, or, in other words, through the E., S.E., S., and so on to S.W., &c., and not round in the contrary way, or in opposition to the sun; and indeed I may here take the opportunity of remarking that, in all my long experience of recording storms at Culloden during the last twenty-three years, I cannot recall an instance in which the wind veered in any other direction than with the course of the sun; and a little in advance of the veering of the wind, a corresponding change takes place in the *carry* of the clouds above. All our great storms begin with wind at S.S.E. to S.E. It then

gradually comes to S.S.W., when some of the heavier blasts occur; with the further veering of the wind through S.W. and W.S.W., there is often a decline in its force till it becomes due W.; and it is when the wind is rapidly veering over this point to W.N.W., and occasionally still more to N.W., that the violent squalls break out, and the height of the storm occurs. The rising of the barometer begins almost invariably when the wind has got as far round from the southern points as W.S.W., or rather, more correctly speaking, with the change, as indicated by the clouds, of the upper current, which, as I have said before, is shortly in advance of the change of wind below. On the abatement of a storm, or some little time after it, the wind again becomes W.S.W. It has appeared to me difficult to see how the cyclone theory can hold good in the storms that cross our latitudes." Observations taken at Portree, East Yell, and Bressay, for which I am indebted to Mr. Buchan, Secretary of the Scottish Meteorological Society, confirm in an indirect manner the accuracy of the preceding remarks by Mr. Forbes as regards this storm. These three stations are on the same side of the storm-path as Culloden and Sandwick; and there is no evidence to show that the veering of the wind was otherwise than through S.E., S., S.W., and W. At Portree, in the Isle of Skye, the observer notes the direction of the wind on the 29th, at 9 A.M., as S.S.E., and at 9 P.M. N.W., and adds, "Cold and cloudy. Gale from N.W. from 8 P.M. to 1 A.M." (30th). In the Shetland Islands the crisis of the storm occurred in the small hours of the morning of the 30th; but at 9 P.M. on the 29th the wind was from E.S.E. at East Yell, and from W.S.W. at the same hour next morning; and at Bressay the observer remarks on the 30th, "Violent gale since 4 A.M."—evidently the same westerly gale that was felt at Sandwick two hours previously.

The further progress of the storm cannot be assigned with certainty, from want of observations in the Feroe Isles and on the coast of Norway; but we may infer that it reached the Norwegian coast about 8 or 9 o'clock in the morning, and that its character was considerably modified by the Scandinavian chain, if indeed this range of mountains did not lead to its entire dispersion.

Tables II. and III. embody the principal facts relating to the barometrical pressure and the force and direction of the wind: they should be carefully studied. Plates XXIII. and XXIV. will, however, convey more information at a glance than many pages of letter-press. More extensive Tables for reference are given at the end.

II. Table showing the Direction of the Wind when the Storm of October 29th commenced, its retrograde movement and subsequent change in direct rotation, with the total amount of change in degrees.

	Distance in Miles from the Central Path.	Retrograde Movement from	Degrees.	Direct Movement from	Degrees.	Total change in degrees.
			°		°	°
Leckpatrick ...	27	....	...	S.E.—N.W.	180	
Culloden	33	S.E.—E.N.E.	67	E.N.E.—W.	202	269
Armagh	78	S.—E.S.E.	65	E.S.E.—W.	151	216
Sandwick	100	....	...	S.E.—W.	135	
Liverpool	226	S.S.E.—S.E. by E.	34	S.E. by E.—W.S.W.	124	158
Nottingham ...	304	S.—S.S.E.	22	S.S.E.—S.W.	67	89
Birmingham ...	307	S.—S.S.E.	22	S.S.E.—S.W.	69	91
Oxford	357	S.S.E.—S.E.	22	S.E.—S.S.W.	68	90
Greenwich	410	S.W. by S.—S. by W.	23	S. by W.—W. by S.	67	90

III. Table showing the Barometrical Minima during the Storm of Oct. 29, Hour of Occurrence, and Direction of the Wind at the Time; also the Greatest Force and Velocity of the Wind, and Time of Occurrence.

	Distance in Miles from the Central Path.	Date and Hour of observed lowest Barometrical Reading.	Barometer reduced to sea-level.	Direction of the Wind.	Greatest Force and Velocity of the Wind during the Storm, and Time of Occurrence.
		d h m	inches.		
New Pitsligo ...	5	29 9 0 P.M.	28·11	S.W.	
Stronvar	20	1 0 P.M.?	28·27?		
Leckpatrick ...	27	0 15 P.M.	28·30	Calm.	
Culloden	33	7 15 P.M.	28·26	Calm.	12 lbs. at 11 P.M.
Greenock	33	3 0 P.M.	28·40		
Glasgow	45	....	...	......	35 lbs. at 7.30 P.M.
Barry	52	8 0 P.M.	28·41		
Armagh	78	11 58 A.M.	28·44	S.W. by W.	Average 37 miles per hour between 1 P.M. and 2 P.M.
South Cairn ...	80	....	28·46	......	
Portree	86	29 5 0 P.M.	28·37	......	
Sandwick	100	30 1 0 A.M.	28·28	W.	Average 74 miles per hour from 1.30 A.M. till 4 A.M. on 30th.
Cockermouth...	146	29 2 0 P.M.	28·72	......	27 lbs. between 2 and 3 P.M.
Bywell	165	3 0 P.M.	28·83	S.W.	
Otley	224	3 0 P.M.	28·92	......	
Liverpool	226	2 0 P.M.	28·98	S.S.W.	19·1 lbs. at 7 P.M.
Wrottesley......	290	....	...	......	12·1 lbs. at 2.30 P.M.
Nottingham ...	304	5 0 P.M.	28·96	S.W. by S.	8·5 lbs. at 3.25 P.M.
Birmingham ...	307	....	...	......	17 lbs. at 3.30 P.M.
Oxford	357	2 30 P.M.	29·22	S.S.W.	Average 29 miles per hour from 2 P.M. till 4 P.M.
Little Bridy ...	384	0 30 P.M.	29·28	S.W. by W.	
Greenwich	410	4 5 P.M.	29·23	W.S.W.	13·5 lbs. at 3.50 P.M.

There are a few points in connexion with these to which I would allude. The velocity of progression of the storm seems to have been considerably retarded by the Highlands of Scotland. Drawing perpendiculars from the several stations to the axis-path of the storm, and measuring along the line, it will be found that the centre advanced from the neighbourhood of Leckpatrick to Greenock, a distance of about 130 miles, between 12.15 P.M. and 3 P.M., or at the rate of 47 miles an hour; while from the latter place to near Culloden, only 90 miles further on, four hours fifteen minutes intervened, the rate of progression being reduced to 21 miles an hour. Another fact should not be overlooked. Within 300 miles of the centre, the amount of veering of the wind is proportionate to the distance from the centre; but it is the same in amount for distances exceeding 300 miles; and in every instance the direct movement is in excess of the retrograde.

The force of the wind and its velocity increased somewhat irregularly towards the centre. Starting with a pressure of 13·5 lbs. on the square foot at Greenwich, we find the most severe squall giving a pressure of 17 lbs. at Birmingham, 19·1 lbs. at Liverpool, 27 lbs. at Cockermouth, and 35 lbs. at Glasgow; and at Sandwick the velocity (37 miles in the half-hour previous to the overthrow of the anemometer) is equivalent to an average pressure of 27 lbs. on the square foot; but intermediate stations suffered much less, and Wrottesley, Highfield House, and Culloden escaped the full severity of the storm. Mr. Burder observes that "at Clifton the winds of the 29th, 30th, and 31st were more than usually fitful. It could scarcely at any time be said that there was a continuous gale; but there was a succession of violent squalls accompanied by rain, and I do not think it blew hard at any time except with this accompaniment. The wind oscillated between the points south and west, in no case exceeding these limits unless for a very short time."

The recorded readings of the barometer for the 29th and following days are fully detailed in the sequel. On the 28th there was the usual small sharp rise preceding a great depression. At the Glasgow Observatory the barometer rose 0·105 in. between 9 A.M. and 9 P.M. At Oxford the rise was 0·042 in. from noon to 6 P.M.; and at Greenwich 0·038 in. between 4 P.M. and 9 P.M., the previous fall in each case having been steady and continuous, and the amount of rise proportionate to the proximity of the central path of the storm. The rapidity and extent of the succeeding fall at any place is influenced still more strongly by this

position with regard to the centre—though, strictly speaking, we should say that the path of the storm is determined by the extent of barometrical depression.

		in.
At New Pitsligo	the fall was	1·34
„ Culloden	„ „	1·19
„ Highfield House, Nottingham	„ „	·70
„ Oxford	„ „	·46
„ Little Bridy	„ „	·41
„ Greenwich	„ „	·40
„ Paris	„ „	·16

As to the rapidity of fall, we find that at Galway the reading of the barometer was 29·58 in. at 9 P.M. on the 28th, next morning at 9 A.M. it was 28·54 in., and rising; the rate of fall must therefore have been at least 0·1 in. per hour during eleven hours. At Stronvar, among the Perthshire Highlands, if the entry be correct, the fall was extraordinary, no less than ·80 in. between 9 A.M. and 1 P.M., or 0·20 in. per hour. At Milltown, the hourly rate of fall was 0·12 in. between 9 and 11.30 A.M.; at Culloden, nearly ·09 in. for the ten hours preceding the minimum, 0·12 in. between 4 P.M. and 5 P.M. In fact, over all Ireland, Scotland, and the North of England, the hourly rate of fall reached 0·10 in. for some time while the depression was in progress. This sensibly diminished in England; at Liverpool, the greatest fall from one hour to another was 0·09 in., and at Oxford 0·06 in.

It is worthy of remark that the increase of barometrical pressure is greatest to the east and south-east of the centre, as shown in the maps, by the comparative crowding of the lines of isobarometrical pressure in that direction. This is most probably the cause of the non-development of the rotation of the wind through N.E., N., N.W., and W. at Sandwick and other places on the left-hand of the centre; and that this generally obtains in our winter-storms is due to the warm waters of the Atlantic discharging an abundance of vapour into the atmosphere, and thereby producing a feeble tension to the west and north-west of the British Isles*. When, in a storm, the pressure increases uniformly in every direction from the centre, we have a true cyclone, as, to cite one instance out of several I have noticed, on October 25th and 26th, 1859.

Temperature, Humidity, and Fall of Rain.—Under a clear sky,

* At Sandwick, on October 30th, the temperature of the sea at one fathom below the surface was 50°·5; the temperature of the air was 40°.

the night of the 28th–29th was frosty in Scotland, the temperature ranging from 28° to 35°; in the North of England and Ireland it was also cold and fine; at Armagh the approach of the storm was heralded by a brilliant lunar halo at 10 P.M.; and in several places, as at Nottingham, there was a radiation-fog. In the south and south-east of England the sky was cloudy, and the lowest temperature about 44°. On the following morning the temperature rose quickly where it had been low; the maximum was nearly coincident in time with the barometrical minimum, reaching 46° at Sandwick, 45° at New Pitsligo, 49° at Montrose, 45° at Portree, and 47° at Leckpatrick; at Culloden the maximum, 45°, occurred at 8 P.M. (three-quarters of an hour after the barometrical minimum), declining to 40° at 10 P.M., and in the night to 36°. In England the temperature was higher, but the range less. At Nottingham the maximum, 52°, was experienced at 2 P.M., just before the termination of a shower of rain; and at Greenwich, the maximum, 54°, preceded the crisis of the storm by an hour; at Upwey, in the south, the highest temperature was 56°. After the barometer had begun to rise, the temperature fell everywhere, the amount of fall, roughly speaking, being about 10° or 12°. The depth of rain that fell, and the time at which it fell, varied very greatly; the amount of fall varied from a few hundredths to nearly an inch, according to exposure and locality, the larger fall taking place in the west and north. In the south of England, much rain fell on the early morning of the 29th, and the weather cleared in the afternoon; at Nottingham rain first fell at 6.15 A.M., and it was fine after 2 P.M.; at Birmingham, 0·04 in. fell between 0.45 P.M. and 2 P.M., and there was very little either before or after; and at Culloden showers came on at 4 P.M. In the evening, showers of hail and sleet were frequent, except in the south and east, and snow fell at Leckpatrick and Manchester. The humidity of the atmosphere, near the surface, was also very variable. In the morning and in the middle of the day, while rain was falling, the air was nearly saturated with vapour; but in the latter part of the gale it became much drier, notwithstanding the heavy showers. At Nottingham, taking saturation =100, the relative humidity was, at 6 A.M. 92, at 1 P.M. 85, and at 6 P.M. 75.

OBSERVERS' REMARKS.—1863, October 29th.

Bressay, Shetland.—Breezy, showery day.
Stornoway, Lewis.—Rain at night, cold.
Greenock.—Hail.

Barry, near Dundee.—The gale began here about 11 A.M. of the 29th, and ended about noon on the 30th.

Balfour, Fife.—A gale, highest from 8 to 12 P.M.

Milne Graden.—High wind from 4 P.M. till 2 next morning.

South Cairn, near Stranraer.—Morning dark and cloudy. A fearful storm. Barometer sank at one time to 28·46 in.

Leckpatrick is situated on the ridge of hills on the east side of the valley of the river Foyle. As soon as the storm veered to the west and north, we had cold hail and sleet showers; at 11.30 P.M., snow.

Salt Hill, Galway.—Heavy showers; strong gales.

Milltown, Banbridge.—Blowing almost a hurricane at night.

Carlisle.—Hail-showers.

Stonyhurst.—Hail.

*Otley**.—Calm foggy morning; showery, windy, and wild afternoon; very wild evening and night, with great wind and heavy showers of hail and rain.

Old Trafford, Manchester.—A very heavy hail-shower at 6·30 P.M.; at 0·30 A.M. on the 30th some snow fell.

Nottingham.—

h	m	
3	0 A.M.	Still foggy.
6	15 A.M.	Fog cleared off; rain commenced.
9	0 A.M.	Fair and windy.
11	0 A.M.	Fine; more wind.
1	15 P.M.	Gale commenced, with rain.
1	30–2 0 P.M.	Heavy shower; then fine, with gale.
7	20 P.M.	Still gale and fine.

Clifton.—Mostly cloudy; a few showers. At 6 P.M., hail. Strong wind from S. to W., at times nearly a gale.

Upwey, near Dorchester.—Rain, with strong S.W. wind; afternoon fine, but strong wind from S.W.

Guernsey (6 A.M. to 6 P.M.).—Strong wind, with heavy squalls from W.S.W.; after 6 P.M., boisterous gale from S.S.W.

Storms of October 30th.

We have now followed the great storm of October 29th until the traces were finally lost in the North Sea, between the Shetland Islands and Norway. When it burst forth in full fury on the Shetland Islands, at 4 A.M. on the morning of the 30th, it had declined to a breeze for some hours in the south of England. But

* Otley, latitude 50° 54′ N.; longitude 1° 42′ W.

already there were ominous symptoms of a fresh storm impending: the wind began to back towards the south, and the barometer to fall; and on this day there is evidence of two distinct storms, or rather seats of primary disturbance—one in the south of England, the other to the north of Scotland. I will first describe that to the north of Scotland, as there is but little to say on the subject. The lowest reading of the barometer took place late at night, and was not generally observed.

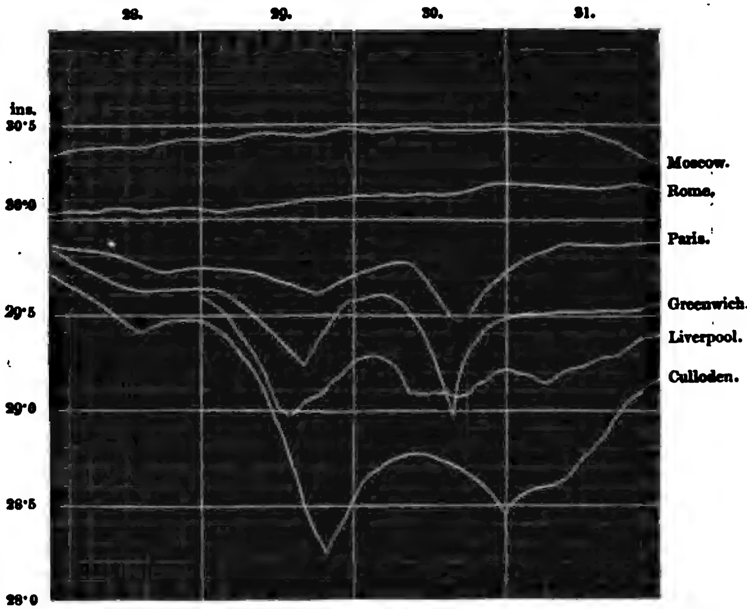
At *Culloden* the barometer had, by 9 A.M., risen half an inch from the minimum of the evening before, and there was a brisk breeze from S.W.; it soon began to fall, and in the afternoon a stormy wind rose from W.S.W., with rain: its force was estimated at 16 lbs.; the minimum reading of the barometer, 28·44 in., was observed at midnight, after which it was less stormy.

At Sandwick the wind remained in the south, to which point it had backed on the former storm, moderating, and gradually declined to a dead calm at 2 A.M. on the 31st, "and remained so till 4 A.M., when it went W., and gradually veered northward till 10 A.M., when it was N.W., and remained so till 10 A.M. on the 1st of November, being moderate all this time, except a few hours on the afternoon of the 31st, when we had a smart breeze, the strongest being 35 miles an hour about 5 P.M." The evening of the 31st was cloudless at Sandwick. The lowest observed reading of the barometer was 28·39 in. at Portree, in Skye, at 9 P.M., the wind being W.S.W. This would seem to indicate the centre of the depression as somewhere off the Hebrides: it was then travelling eastward, probably from S.W. by W. to N.E. by E., at a rate of 30 miles an hour; for the minimum at Culloden was 0·05 in. higher than at Portree, and it was later by two hours, while at Sandwick the calm from 2 A.M. till 4 A.M. fixes the time of passage within moderate limits. The weather was very cold in Scotland, with showers of rain, hail, and snow, and in some places thunder and lightning. The influence of this storm extended southwards as far as Liverpool, where it caused the wind to back a few points early on the morning of the 31st, and interrupted the rise of the barometer (see fig. 8).

The other storm was experienced in the south of England, and was of a different character; it was much more severe: the barometrical oscillation was very sharp, and the minimum accompanied by a tremendous shower of rain and hail, and violent squall of wind, shifting suddenly from S.W. to N.W., and lowering the temperature several degrees. The violent squall was confined to the south

and south-east of England, the most northerly point at which it was noticed being Kirkstead, in Lincolnshire. There was the sudden shift in the wind both at Birmingham and Wrottesley; all day, however, there was a high wind throughout Great Britain.

Fig. 8.—*Barometrical Fluctuations, October* 1863.



Liverpool was not involved in this sudden storm. The wind gradually backed from W.S.W., at 1 A.M., to S.E. by S. at 8 A.M., returning to W. at 11 A.M., and subsequently oscillating between W. and S.W. Heavy rain fell from 5.30 A.M. to 0.30 P.M., producing 0·93 in. depth in the gauge. The greatest force of the wind was 14·2 lbs. at 4.15 A.M., during a shower from W.S.W.; but between noon and 3 P.M., the wind did not exceed a brisk breeze. The fall of the barometer was suddenly checked at 8 A.M., and the reading was nearly constant till 5 P.M., after which it rose.

At *Wrottesley* the wind shifted from S. by W. to W. by N., a few minutes after midday, in a heavy shower, and rain continued to fall till 1.40 P.M.; but there was no heavy gust of wind. The depth of rain that fell was 0·28 in.; and soon after it ceased, the wind returned southwards. The greatest force of the wind on this day was 10·6 lbs. on the square foot at 3.40 A.M.; the direction of the wind was S.S.W.

At *Birmingham* the shift of the wind took place at 1 P.M. in a shower, the air being nearly calm; the change was from S. by W. to W.S.W., gradually reaching W.N.W. at 1.40 P.M. The depth of rain from 0.40 P.M. to 2.10 P.M. was 0.18 in. The greatest force of the wind was 21·3 lbs., from S. by W., at 11.2 A.M.

At *Oxford*, from 9 A.M. till 2.30 P.M. rain fell; at 2.30 P.M. there was a shower of hail, after which the sky became clear, and continued so till nearly midnight. Lightning was seen low down in the W., while the sky was quite clear, about 11 P.M. "The storm of wind was not very violent here, and there was no violent gust." The shift of wind accompanied the hailstorm, and was from S. by W. to W. by N.; and an hour afterwards the wind began to back to the S. The shift of wind was accompanied by a very considerable fall of the temperature: since 7 A.M. the thermometer had ranged between 49° and 51°; at 1.50 P.M. it was 54°·4, at 2.30 P.M. 44°·8, at 5 P.M. 41°·4, and at 8.10 P.M. 40°·6. The barometer fell from 1 A.M. till 2.30 P.M.; it rose suddenly from the lowest point no less than 0·04 in. within four or five minutes.

At *Greenwich*, the minimum reading of the barometer, the shift of wind in a violent squall, and the maximum temperature, all occurred at the same moment. The force of the wind, after oscillating from 12 to 15 lbs., suddenly rose to 29·5 lbs. on the square foot, but sank to 5 lbs. in a very few minutes; the direction changed from S.W. to N.W. by N. at 3.30 P.M., but gradually retrograded to W. by S. at 7 P.M. The squall of wind was accompanied by a very heavy shower of rain. The temperature fell considerably: it was 53°·3 at 3.20 P.M., 46°.0 at 4 P.M., and 40°·5 at 9 P.M. It is worthy of note, that the force of the wind on this occasion was the greatest that had occurred since the establishment of the anemometer in 1840. In the hour succeeding the squall, the barometer rose 0·20 in.

This crisis of this remarkable storm was observed at several other stations.

At *Clifton*, Mr. Burder states that it was rainy till 2 P.M., the rain being very heavy about 1 P.M. The lowest reading of the barometer preceded the shift of wind to N.W. by W. at 1.40 P.M.

At *Upwey*, Mr. Miller appends a note to the effect that there was heavy rain and a strong S.W. wind, moderating in the afternoon; "at 1.45 P.M., the barometer reading 29·04 in. (the lowest point during the gale), a furious squall from the S.W., with rain, occurred, lasting about a quarter of an hour (the maximum of the

storm); the weather then moderated, and the wind veered to the W."

At *Osborne*, "on the 30th October, at ¼ to 3 P.M., an extraordinary rush of wind passed over here, with a tremendously heavy shower of rain, which rendered objects at 200 yards' distance invisible. Its force was, I imagine, 14 lbs.; but it could not have exceeded this, as it was the greatest pressure indicated by the anemometer-pencil on that day. The rain that fell during the rush of wind (it lasted 3 or 4 minutes) was fearful. I was outside, and being near a tree, I went under it for shelter; but the rain fell so tremendously, falling in what I may term sheets of water upon a strong umbrella I carried, that I unconsciously put the umbrella aside, and looked up into the tree, wondering what next was about to happen. Several persons I saw immediately afterwards spoke of the tremendous shower with surprise, stating that they had never before seen such. The upper clouds were stationary at 3 P.M.; the barometer was 29·18 in.; the direction of the wind W., and its force 7 lbs. on the square foot."

At the *Kew Observatory*, Mr. Stewart has recorded that, on the afternoon of the 30th, a very violent and sudden gust of wind put out the gaslights in the room containing the barograph, fixing the time of the passage of the squall at $3^h\ 9^m$ P.M., G. M. T., in this locality. Mr. Stewart believes that a sudden increase of barometrical pressure accompanied the gust of wind at the moment when the gas went out*.

At *Kirkstead in Lincolnshire*, Mr. Cator observed that the morning of the 30th was clear till 9 A.M., when it clouded over and began to rain at noon; it continued raining fast till 3 P.M., when, in a tremendous fall of rain and hail, the wind veered from S.W. to N.W.; the rain continued till 4 P.M., and the wind gradually went down, and the sky became clear. The temperature of the air was 50° at 2 P.M., 39° at 3.30 P.M., and at the same point at 5.30 P.M., at which time the wind had become W., and the sky quite clear.

At *Nottingham* the morning was calm, wind about S. At 6.30 A.M. a gale suddenly set in, but moderated at 1.30 P.M.; at 1 P.M. rain commenced, and from 1.35 P.M. till 2.30 P.M. there was a heavy fall of rain and hail (0·18 in.). The direction of the wind changed from S. to W. at 1.25 P.M., veering to S.W. by 5.50 P.M., and S.W. by S. at 8 P.M.

* *Vide* Proc. Brit. Meteor. Soc. vol. ii. p. 51.

TABLE IV. Showing the Change in the Direction of the Wind, and Force in lbs. pressure on the square foot; also lowest point attained by the Barometer.

	Hour.	Wind changed from	Degrees.	Force.	Barometer.
	P.M.		°	lbs.	inches.
Wrottesley......	0.10	S. by W. — W. by N.	93	2·1	
Clifton	1·40	S.S.W. — N.W. by W.	101	......	29·10
Birmingham ...	1	S. by W. — W. by S.	67	0·6	
Little Bridy ...	1	....	......	violent	29·05
Upwey	1.45	S.W. — W.	45	violent	29·04
Nottingham ...	1.25	S. — W.	90		
Oxford	2.30	S. by W. — W. by N.	90	......	29·02
Osborne.........	2.45	....	......	14·0	
Kirkstead	3	S.W. — N.W.	90	violent	
Greenwich......	3.25	S.W. by W. — N.N.W.	103	29·5	28·97

On carefully comparing the above observations, it will be found that the results are accordant, if we assume that a belt of low barometer traversed the middle and south of England from W. by N. to E. by S. (W. 15° N. to E. 15° S.), at a rate averaging 30 miles an hour in the latitude of Birmingham and also in the extreme south of England, and 50 miles an hour in the latitude of Oxford, making some allowance for the time being not noted exactly; that, prior to the passage of the trough of the barometrical wave, the wind blew from the S. by W. at a right angle to its path; and that after it had passed, the wind shifted and blew parallel to its course. Thus the wind shifted from S. to W. almost simultaneously at Birmingham and Little Bridy, and at Kirkstead and Osborne.

The barometrical pressure was less in the north and west of England than in the south-east during the morning hours; but the difference rapidly diminished towards midday; and after the squall was developed, at any given instant along the line of minimum pressure the value was nearly the same. I have already noticed that the pressure at Liverpool scarcely varied from 8 A.M. to 5 P.M.; and this holds good for the various places on the northern margin of the tract affected, which therefore affords a tolerably safe comparison for stations in the south, where the barometrical oscillation was violent, although the times of observation may not be exactly coincident. The depression was evidently increasing, and the storm becoming more violent, in its eastward progress. At 1 P.M. the value of the depression was about 29·05 in., from observations at Little Bridy, and, interpolating for Wakefield, we obtain the same value for the north; at 2.30 P.M. the Oxford observations give

29·02 in., and at 3.25 P.M. the value of the barometrical reading was 28·97 in.: it was probably somewhat lower at Wisbeach at this time, as it had been 28·96 in. at 3 P.M., before the change of wind. We learn also that the belt of low barometer was much narrower in the south, and the oscillation was therefore much more sharp: thus at Greenwich the barometer rose 0·20 in. between 3.25 P.M. and 4.25 P.M.

At 3 P.M. the squall extended in a line from Kirkstead, through Bedford, and so on to the eastern extremity of the Isle of Wight, rain and hail falling everywhere along the line in torrents, and the shift of wind occurring as has been noticed. Soon after its passage, within two or three hours, the barometer had risen considerably higher in the south than it was in the north; the uniform decrease of pressure in proceeding from south to north was re-established, and the wind returned to S.W. The approximation of the readings of the barometer in the north and south is well seen in fig. 8, p. 124, where the curve described by the Greenwich barometer temporarily dips below the Liverpool curve. Table V. gives an abstract of the meteorological observations taken at 3 P.M. on the 30th.

TABLE V. Showing the Height of the Barometer, Direction of the Wind, and the Temperature, 1863, October 30th, 3 P.M.

	Barometer at Sea-level	Wind.	Temperature.
	inches.		°
Culloden	28·73	S.W.	
Bywell	28·95	W.	
Otley	28·96	S.W.	
Wakefield	29·03	W.S.W.	40
Liverpool	29·06	S.W.	45
Wisbeach	28·96	S.S.E.	51
Oxford	29·11	W. by N.	43
Greenwich	29·02	S.S.W.	52
Bath	29·20		
Barnstaple	29·31		
Exeter	29·27	N.W.	44
Osborne	29·18	W.	47
Truro	29·31	N.W.	47
Helston	29·37	W.	
Guernsey	29·32	S.S.W.	53
Paris	29·51	S.S.W.	56

In the above, the stations included between Wisbeach and Helston were alone affected by the squall.

It is difficult to assign a cause for this ripple in the atmosphere, yet it may have received its first impulse or have been an offshoot from the storm that was at this time approaching the N.W. coast

of Scotland, already described, and which was of much larger dimensions. Its immediate effect was the lowering of the temperature some 8° or 10°, and a copious precipitation of rain and hail, after which the air became much drier.

There is nothing remarkable to notice concerning the weather on the 31st. The violent winds of that and the preceding day gave rise to considerable electrical action; and thundersterms with rain, hail, and snow were experienced at many places. In the night of the 30th–31st, there was a heavy fall of rain; and next day the depression went off eastward in the ordinary manner, the gale veering from S.W. to W. and N.W., and the air continuing cold and very dry in the intervals of the showers.

The weather on November 1st was, upon the whole, fine; but the barometer fell rapidly at night in the middle and south of England. The lowest reading occurred about sunrise on the 2nd; it then rose very rapidly, and a violent westerly gale succeeded, after which the weather became fair. This final storm travelled from west to east, and was preceded by much rain. The progressive change in direction of the wind was similar to that of the previous storm.

OBSERVERS' REMARKS.—1863, October 30th.

Sandwick.—Showers of sleet A.M.; fine at midday, and clear P.M.

Stornoway.—Gleams of sunshine; hail- and snow-showers; very cold.

Portree.—Thunder and lightning at 11.30 A.M. and 3.30 P.M., followed by heavy hail-showers and squalls, snow falling thick on the hills; lightning all the evening. Rain-fall 1·21 in.

Greenock.—Showers of rain and hail; lightning at night.

Balfour.—Rain and snow in the morning; lightning at night.

Milne Graden.—High wind at night.

South Cairn.—Forenoon clear and dry; afternoon cloudy, with slight showers; evening cold. Rain-fall 0·30 in.

Carlisle.—Hail-showers; lightning seen during the night.

Stonyhurst.—Hail. Rain-fall 0·75 in.

Allenheads.—Heavy showers of sleet and snow during the day. Rain-fall 0·64 in.

Bywell.—Rain-fall 0·25 in.

Milltown.—Great storm at night. Rain-fall 0·23 in.

Otley.—Rainy. Cloudy afternoon. Very wild night; great

wind; showers of rain and hail. Thunder and lightning from 11.30 P.M. to midnight.

Belvoir Castle.—Stormy; hail and rain; gale of wind.

Wisbeach.—Fresh. Rain 10 A.M. Heavy squall, with hail, at 3.35 P.M.

Grantham.—Very stormy all night; gusts very violent, with frequent squalls of rain, till about 3 P.M. Evening fine.

Berkhampstead.—High wind all day. Heavy rain till 3.30 P.M.

Nottingham.—0.40 A.M. gale moderated; 2.40 A.M. nearly calm; 6 A.M. still nearly calm; 6.30 A.M. fine, suddenly a gale.

Bath.—Heavy showers, thunder and lightning, hail. Rain-fall 0·62 in.

Clifton.—6 P.M. several flashes of lightning; 11 P.M. vivid lightning and thunder; 11.35 P.M. strong and fitful squalls, rain, and hail. Rain-fall 0·74 in.

Little Bridy.—Many trees blown down. Rain-fall 0·66 in.

OBSERVERS' REMARKS.—1863, October 31st.

Bressay.—Rain, in violent showers, all day.

Sandwick.—Scuds A.M.; sleet-showers P.M. Rain-fall 0·02 in.

Portree.—Heavy hail-showers and snow on hills. Rain-fall 1·09 in.

South Cairn.—Last night wet and stormy; heavy squalls of wind and bitter showers all day.

Nottingham.—1 A.M. till 2.30 A.M. gale, then moderated to brisk breeze; 5.50 A.M. again gale, lasting till midnight, and reaching 12 lbs. pressure at 6.20 A.M.; at 6·40 A.M. violent squall for 10 minutes (8 lbs. pressure), then 2¼ lbs. till 7.50 A.M., then a similar squall, after which a regular gale set in, most violent from 9.10 A.M., being 11 lbs. pressure on square foot; 10 A.M., still 11 lbs. pressure, with slightly rising barometer; 10.20 A.M., 12 lbs. pressure, temperature 47°·5, wet-bulb 41°·3; gale as violent till 2.40 P.M.; 5.20 P.M., still gale, temperature 47°·5, wet-bulb 42°·0; 8 P.M., slight rain, with gale.

Clifton.—Thunder-storms at 1 A.M. and 5 A.M., with heavy rain, hail, and wind. Partially clear day, with smart showers of rain and hail. In evening frequent rain; wind strong and squally, from W.S.W., becoming stronger in evening, and at 11 P.M. very violent. In the storm at 1 A.M., one flash was within half a mile; at 5 A.M. several about three miles.

Upwey.—Sunny, with passing cumuli; strong S.W. wind; hail-storm at 3 P.M., stones size of horse-beans.

Barometer, reduced to sea-level, 29 October, 1868.

Hour.	East Yell. Lat. 60° 33′ N. Long. 1° 3′ W. 176 ft. above sea.	Bressay. Lat. 60° 10′ N. Long. 2° 48′ W. 25 ft. above sea.	Sandwick. Lat. 59° 2′ N. Long. 3° 18′ W. 94 ft. above sea.	New Pitaligo. Lat. 57° 20′ N. Long. 2° 6′ W. 501 ft. above sea.	Culloden. Lat. 57° 31′ N. Long. 3° 18′ W. 104 ft. above sea.	Portree. Lat. 57° 21′ N. Long. 6° 8′ W. 50 ft. above sea.	Barry. Lat. 56° 31′ N. Long. 2° 44′ W. 35 ft. above sea.	Montrose. Lat. 56° 43′ N. Long. 2° 26′ W. 14 ft. above sea.
1	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
2								
3								
4								
5								
6								
7								
8								
9	29·37	29·38	29·24	29·19	29·15	29·01	...	29·26
10								
11	...	...	...	...	...	...	29·08	
Noon	...	...	...	...	...	...	29·04	
1	...	...	...	...	...	28·61	...	
							28·87 at 1·30	
2	...	...	...	...	...	...	28·81	
							28·76 at 2·30	
3	...	...	...	...	...	...	...	
							28·66 at 3·30	
4	...	...	...	...	2 8·56	...	...	
							28·58 at 4·30	
5	...	...	...	...	28·44	28·37	...	
							28·51 at 5·15	
6	...	...	...	...	28·37	...	28·47	
7	...	...	...	...	28·30	...	28·45	
					28·26 at 7.15			
8	...	...	...	...	28·28	...	28·41	
							28·42 at 8·30	
9	28·64	28·53	28·39	28·11	28·33	28·49	28·45	28·42
10	...	...	28·34	...	28·42			
11	...	...	28·31	...	28·50			
12	...	...	28·29					

Barometer, reduced to sea-level, 29 October, 1863.

Hour.	Stronvar. Lat. 56°·23′ N. Long. 3°·56′ W. 460 ft. above sea.	Balfour. Lat. 56°·11′ N. Long. 3° 11′ W. 130 ft. above sea.	Greenock. Lat. 55° 57′ N. Long. 4° 45′ W. 64 ft. above sea.	Baillieston. Lat. 55°·57′ N. Long. 4° 6′ W. 242 ft. above sea.	Milne Graden. Lat. 55° 41′ N. Long. 2° 12′ W. 100 ft. above sea.	South Cairn. Lat. 54° 58′ N. Long. 5° 2′ W. 209 ft. above sea.	Lockpatrick. Lat. 54° 50′ N. Long. 7° 25′ W. 260 ft. above sea.	Armagh. Lat. 54° 21′ N. Long. 6° 39′ W. 236 ft. above sea.
1	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
2								
3	...	...	...	...				
4	...		...	...				
5								
6	...	...		...				
7								
8	...	...	...	...	...	...	...	28·80 at 8.30
9	29·07	29·24	29·15	29·15	29·31	29·18	28·63	
	...	...	...	...	...	...		28·77 at 9.2
10	...	...	...	...	...	...	28·45 at 10.30	28·59 at 10.10
	...	...		...	...	...		28·57 at 10.50
11	...	...	...	...	...	...	28·40	
	...	...	...	...	...		28·35 at 11.30	28·44 at 11.58
Noon	...	...	...	...	...	...	28·32	
	...	...	...	...	...			28·49 at 12.40
1	28·27	...	...	...	...	...	28·32	
							...	28·56 at 1.10
								28·64 at 1.50
2	...	...	...	...	...	...	28·40	
								28·69 at 2.34
3	...	...	28·40	...	...	...	...	28·73 at 3.13
								28·80 at 3.43
4	...	...	...	...	...	...	28·60	
								28·84 at 4.32
5	...	...	...	...	...	...	...	28·86 at 5.5
6	...	...	...	...	...	...	28·72	
								28·89 at 6.36
7	...	...	...	28·50				
8	...	...	...	...	...	...	...	29·01
9	28·44	28·57	28·67	28·66	28·90	28·89		
10	...	...	...	...	...	...	...	29·10 at 10·5
								29·11 at 10·52
11	...	...	...	...	...	...	28·90 at 11·30	
12								

Barometer, reduced to sea-level, 29 October, 1868.

Hour.	Milltown. Lat. 54° 23′ N. Long. 6° 18′ W. 200 ft. above sea.	Salt Hill, Galway. Lat. 53° 17′ N. Long. 9° 0′ W.	Bywell. Lat. 54° 57′ N. Long. 1° 56′ W. 87 ft. above sea.	Warrington. Lat. 53° 23′ N. Long. 2° 31′ W. 96 ft. above sea.	Stonyhurst. Lat. 53° 51′ N. Long. 2° 29′ W. 381 ft. above sea.	Silloth. Lat. 54° 52′ N. Long. 3° 22′ W. 28 ft. above sea.	Wakefield. Lat. 53° 47′ N. Long. 1° 30′ W. 115 ft. above sea.	Liverpool. Lat. 53° 25′ N. Long. 3° 0′ W. 30 ft. above sea.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1	...	...	...	...	...	...	...	29·60
2	...	...	...	...	...	...	...	29·58
3	...	...	...	...	...	...	...	29·54
4	...	...	...	...	...	...	...	29·51
5	...	...	...	...	...	...	...	29·46
6	...	...	...	...	...	...	...	29·40
7	...	...	...	...	...	...	...	29·35
8	...	...	...	...	...	...	...	29·30
9	28·84	28·54	29·30	...	29·22	29·20	29·34	29·25
10	...	...	...	...	...	...	...	29·17
11	...	...	...	...	...	...	...	29·09
	28·54 at 11.30							
Noon	...	...	...	...	...	...	...	29·00
1	...	...	...	...	...	...	...	29·01
2	...	...	...	...	...	...	...	28·98
3	...	...	28·83	...	...	...	28·99	29·01
4	...	...	...	...	...	...	...	29·03
5	...	...	...	...	...	...	...	29·06
6	...	...	...	...	...	...	...	29·08
7	...	...	...	...	...	...	...	29·11
8	...	...	...	...	...	...	...	29·15
9	...	29·21	...	29·16	29·05	28·92	29·13	29·18
10	...	...	...	...	...	...	...	29·20
11	...	...	...	...	...	...	...	29·25
12	...	...	...	...	...	...	...	29·27

Barometer, reduced to sea-level, 29 October, 1863.

Hour.	Manchester. Lat. 53° 29′ N. Long. 2° 16′ W. 123 ft. above sea.	Highfield House. Lat. 52° 58′ N. Long. 1° 10′ W. 174 ft. above sea.	Norwich. Lat. 52° 57′ N. Long. 1° 16′ E. 50 ft. above sea.	Wrottesley Hall. Lat. 52° 57′ N. Long. 2° 13′ W. 531 ft. above sea.	Clifton. Lat. 51° 28′ N. Long. 2° 36′ W. 228 ft. above sea.	Oxford. Lat. 51° 46′ N. Long. 1° 16′ W. 210 ft. above sea.	Greenwich. Lat. 51° 29′ N. Long. 0° 0′. 159 ft. above sea.	Truro. Lat. 50° 17′ N. Long. 5° 4′ W. 43 ft. above sea.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1	...	29·52	...	...	...	29·62	29·64	
2	...	...	...	...	...	29·60	29·63	
3	...	...	...	...	...	29·58	29·62	
4	...	29·51	...	...	...	29·54	29·61	
5	...	...	...	...	...	29·51	29·59	
6	...	29·48	...	...	...	29·49	29·55	
7	...	29·44	...	...	...	29·48	29·53	
8	29·36	29·42	...	...	...	29·46	29·52	
9	...	29·36	...	29·35	29·33	29·42	29·48	29·31
10	...	29·34	29·44		...	29·39	29·45	
11	...	29·30	...	...	...	29·33	29·43	
Noon	...	...	...	...	...	29·28	29·38	
1	...	29·16	...	...	...	29·23	29·33	
	29·05 at 1.20	29·10 at 1.20						
2	...	28·99	29·23	...	...	29·22	29·29	
3	...	...	...	29·16	...	29·22	29·26	29·37
4	...	...	...	...	...	29·26	29·24	
							29·23 at 4.10	
5	...	28·96	...	...	29·31	29·30	29·31	
6	...	29·00	...	...	...	29·33	29·33	
7	...	29·10	...	...	...	29·35	29·35	
8	...	...	...	...	...	29·37	29·38	
9	...	...	...	...	...	29·41	29·42	29·48
10	...	29·33	...	...	...	29·42	29·44	
11	29·23	...	...	...	...	29·45	29·45	
12	...	...	...	...	...	29·47	29·46	

Barometer, reduced to sea-level.

Hour.	29 October, 1868. Exeter. Lat. 50° 43′ N. Long. 4° 7′ W. 140 ft. above sea.	Little Bridy. Lat. 50° 41′ N. Long. 2° 34′ W. 367 ft. above sea.	Upwey. Lat. 50° 38′ N. Long. 2° 25′ W. 70 ft. above sea.	Guernsey. Lat. 49° 27′ N. Long. 2° 32′ W. 204 ft. above sea.	30 October, 1868. East Yell. Lat. 60° 33′ N. Long. 1° 3′ W. 176 ft. above sea.	Bressay. Lat. 60° 10′ N. Long. 2° 48′ W. 25 ft. above sea.	Sandwick. Lat. 59° 2′ N. Long. 3° 18′ W. 94 ft. above sea.	New Pitsligo. Lat. 57° 35′ N. Long. 2° 9′ W. 501 ft. above sea.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1	...	...	...	...	...	...	28·28	
							28·28 at 1.20	
2								
3								
4								
5								
6								
7	...	...	...	...	...	...	28·56	
8								
9	29·35	29·40	29·40	29·51	28·43	28·57	28·64	28·81
10								
11	...	...	...	...	...	...	28·69	
Noon.								
		29·28 at 12.30						
1								
2								
3	29·34	...	...	29·47				
4								
5								
6								
7								
8								
9	29·48	29·48	29·47	...	28·69	28·65	28·60	28·61
10								
11								
12								

Barometer, reduced to sea-level, 30 October 1863.

Hour.	Culloden. Lat. 57° 31′ N. Long. 3° 18′ W. 104 ft. above sea.	Portree. Lat. 57° 25′ N. Long. 6° 11′ W. 50 ft. above sea.	Montrose. Lat. 56° 43′ N. Long. 2° 28′ W. 15 ft. above sea.	Stronvar. Lat. 56° 21′ N. Long. 4° 25′ W. 460 ft. above sea.	Balfour. Lat. 56° 11′ N. Long. 3° 11′ W. 130 ft. above sea.	Greenock. Lat. 55° 37′ N. Long. 4° 45′ W. 64 ft. above sea.	Baillieston. Lat. 55° 57′ N. Long. 4° 6′ W. 242 ft. above sea.	Milne Graden. Lat. 55° 41′ N. Long. 2° 12′ W. 100 ft. above sea.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1								
2								
3								
4								
5								
6								
7								
8								
9	28·77	28·66	28·92	28·76	28·96	28·88	28·92	29·01
10								
11								
Noon								
1								
2								
3								
4								
	28·70 at 4.30							
5								
6								
7	28·62							
8								
9	28·58	28·39	28·86	28·61	28·83	28·74	28·81	28·89
10	28·54							
11	28·46							
12	28·44							

Barometer, reduced to sea-level, 30 October, 1863.

Hour.	South Cairn. Lat. 55° 0′ N. Long. 5° 8′ W. 209 ft. above sea.	Leckpatrick. Lat. 54° 50′ N. Long. 7° 25′ W. 260 ft. above sea.	Armagh. Lat. 54° 21′ N. Long. 6° 39′ W. 236 ft. above sea.	Salt Hill, Galway. Lat. 53° 17′ N. Long. 9° 0′ W.	Silloth. Lat. 54° 52′ N. Long. 3° 22′ W. 28 ft. above sea.	Wakefield. Lat. 53° 47′ N. Long. 1° 30′ W. 115 ft. above sea.	Liverpool. Lat. 53° 25′ N. Long. 3° 0′ W. 30 ft. above sea.	Manchester. Lat. 53° 29′ N. Long. 2° 16′ W. 123 ft. above sea.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1	...	...	...	...	...	...	29·28	
2	...	...	...	...	...	...	29·29	
3	...	...	...	...	...	29·24	29·27	
4	...	...	...	...	...	...	29·25	
5	...	...	...	...	...	...	29·24	
6	...	...	...	...	...	...	29·22	
7	...	...	...	...	...	...	29·17	
8	...	...	...	...	...	...	29·09	29·13
			28·98 at 8.10					
9	29·06	28·80	...	29·06	29·02	29·10	29·09	
10	...	...	28·97	...	...	...	29·09	
11	...	...	...	...	...	...	29·10	
Noon	...	...	...	...	...	...	29·09	
1	...	...	...	...	...	...	29·08	
2	...	...	...	...	...	...	29·07	
3	...	...	...	...	...	29·03	29·06	
4	...	...	...	...	...	...	29·07	
5	...	...	...	...	...	...	29·08	
6	...	...	...	...	...	...	29·11	
7	...	...	...	...	...	...	29·14	
8	...	...	...	...	...	...	29·15	
9	28·96	...	...	...	28·97	29·14	29·20	
10	...	28·70	28·96	29·14	...	...	29·20	
11	...	...	...	...	...	...	29·21	29·23
12	...	...	...	...	...	...	29·21	

Barometer, reduced to sea-level, 30 October, 1863.

Hour.	Highfield House. Lat. 52° 58′ N. Long. 1° 10′ W. 174 ft. above sea.	Norwich. Lat. 52° 37′ N. Long. 1° 16′ E. 50 ft. above sea.	Wrottesley Hall. Lat. 52° 37′ N. Long. 2° 13′ W. 531 ft. above sea.	Grantham. Lat. 52° 55′ N. Long. 0° 39′ W. 181 ft. above sea.	Wisbeach. Lat. 52° 41′ N. Long. 0° 9′ E. 14 ft. above sea.	Clifton. Lat. 51° 28′ N. Long. 2° 36′ W. 228 ft. above sea.	Oxford. Lat. 51° 46′ N. Long. 1° 16′ W. 210 ft. above sea.	Greenwich. Lat. 51° 29′ N. Long. 0° 0′. 159 ft. above sea.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1	29·42	...	...	...	...	...	29·50	29·49
2	...	...	...	...	...	...	29·49	29·51
3	29·42	...	...	...	...	...	29·48	29·51
4	...	...	...	...	...	...	29·47	29·51
5	29·44	...	...	...	...	...	29·47	29·50
6	...	...	...	...	...	...	29·47	29·49
7	...	...	...	...	...	...	29·46	29·48
8	...	...	...	...	...	...	29·43	29·47
9	...	...	29·22	29·21	29·29	29·28	29·40	29·42
10	29·24	29·37	...	...	...	...	29·34	29·38
11	...	...	...	...	...	...	29·31	29·34
Noon	...	29·25	...	...	...	...	29·23	29·29
				29·08 at 0.15				
1	...	...	...	...	...	...	29·16	29·20
						29·10 at 1.40		
2	...	29·11	...	...	...	...	29·06	29·13
							29·02 at 2·30	
3	...	...	29·14	...	28·96	...	29·11	29·02
				29·02 at 3·50				28·97 at 3.25
4	...	...	...	...	...	...	29·19	29·09
5	...	...	...	...	...	29·28	29·27	29·24
6	...	...	...	...	...	...	29·33	29·30
7	...	...	...	...	...	...	29·35	29·35
8	...	...	...	...	...	...	29·39	29·39
9	...	...	...	...	...	...	29·43	29·42
10	...	...	...	...	...	...	29·46	29·45
11	29·32	...	...	...	...	...	29·50	29·48
12								

Barometer, reduced to sea-level.

Hour.	30 October, 1863. Barnstaple. Lat. 51° 51′ N. Long. 4° 3′ W. 43 ft. above sea.	Truro. Lat. 50° 17′ N. Long. 5° 4′ W. 43 ft. above sea.	Exeter. Lat. 50° 43′ N. Long. 4° 7′ W. 140 ft. above sea.	Little Bridy. Lat. 50° 41′ N. Long. 2° 34′ W. 367 ft. above sea.	Upwey. Lat. 50° 38′ N. Long. 2° 25′ W. 70 ft. above sea.	Osborne. Lat. 50° 45′ N. Long. 1° 16′ W. 172 ft. above sea.	Guernsey. Lat. 49° 27′ N. Long. 2° 32′ W. 204 ft. above sea.	31 October, 1863. East Yell. Lat. 60° 33′ N. Long. 1° 3′ W. 176 ft. above sea.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1								
2								
3								
4								
5								
6								
7								
8								
9	29·22	29·27	29·31	29·37	29·37	29·38	29·50	28·60
10								
11								
Noon.								
1	...	...	...	29·05	29·04 at 1·45			
2								
3	29·31	29·31	29·27	...	...	29·18	29·32	
4								
5								
6								
7								
8								
9	...	29·57	29·52	29·51	29·52	...	...	28·91
10								
11								
12								

Barometer, reduced to sea-level, 31 October, 1863.

Hour.	Bressay. Lat. 60° 10 N'. Long. 2° 48' W. 25 ft. above sea.	Sandwick. Lat. 59° 2' N. Long. 3° 18' W. 94 ft. above sea.	New Pitsligo. Lat. 57° 35' N. Long. 2° 9' W. 501 ft. above sea.	Culloden. Lat. 57° 31' N. Long. 3° 18' W. 104 ft. above sea.	Portree. Lat. 57° 25' N. Long 6° 11' W. 50 ft. above sea.	Montrose. Lat. 56° 43' N. Long. 2° 26' W. 15 ft. above sea.	Stronvar. Lat. 56° 21' N. Long. 4° 25' W. 460 ft. above sea.	Balfour. Lat. 56° 11' N. Long. 3° 11' W. 130 ft. above sea.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1	...	...	...	28·51				
2								
3								
4								
5								
6								
7								
8								
9	28·56	28·59	28·65	28·64	28·70	28·74	28·64	28·79
10								
11								
Noon.								
1								
2								
3								
4								
5								
6								
7	...	...	...	29·04				
8								
9	28·90	28·98	29·01	...	29·16	29·07	29·05	29·15
10								
11								
12								

Barometer, reduced to sea-level, 31 October, 1863.

Hour.	Greenock. Lat. 55° 57′ N. Long. 4° 45′ W. 64 ft. above sea.	Baillieston. Lat. 55° 57′ N. Long. 4° 6′ W. 242 ft. above sea.	Milne Graden. Lat. 55° 41′ N. Long. 2° 12′ W. 100 ft. above sea.	South Cairn. Lat. 55° 0′ N. Long. 5° 8′ W. 209 ft. above sea.	Leckpatrick. Lat. 54° 50′ N. Long. 7° 25′ W. 260 ft. above sea.	Armagh. Lat. 54° 21′ N. Long. 6° 39′ W. 236 ft. above sea.	Salt Hill, Galway. Lat. 53° 17′ N. Long. 9° 0′ W.	Silloth. Lat. 54° 52′ N. Long. 3° 22′ W. 28 ft. above sea.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1								
2								
3								
4								
5								
6								
7								
8								
9	28·77	28·81	28·80	28·93	28·90	...	29·35	28·91
10	...	...	...	...	...	29·10		
11								
Noon.								
1								
2								
3								
4								
5								
6								
7								
8								
9	29·21	29·17	...	29·31	...	...	29·45	29·24
10	...	...	...	...	29·20			
11	...	...	...	...	...	29·35		
12								

Barometer, reduced to sea-level, 31 October, 1863.

Hour.	Wakefield. Lat. 53° 47′ N. Long. 1° 30′ W. 115 ft. above sea.	Liverpool. Lat. 53° 25′ N. Long. 3° 0′ W. 30 ft. above sea.	Manchester. Lat. 53° 29′ N. Long. 2° 16′ W. 123 ft. above sea.	Highfield House. Lat. 52° 58′ N. Long. 1° 10′ W. 174 ft. above sea.	Norwich. Lat. 52° 37′ N. Long. 1° 16′ E. 50 ft. above sea.	Wrottesley Hall. Lat. 52° 37′ N. Long. 2° 1[illegible]′ W. 531 ft. above sea.	Clifton. Lat. 52° 28′ N. Long. 2° 36′ W. 228 ft. above sea.	Truro. Lat. 50° 17′ N. Long. 5° 4′ W. 43 ft. above sea.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1	...	29·22	...	...	...	...	29·48 at 0·15	
2	...	29·21	...	29·29				
3	29·15	29·19						
4	...	29·18						
5	...	29·15						
6	...	29·13						
7	...	29·13						
8	...	29·16	29·17					
9	29·09	29·20	...	29·32	...	29·38	29·51	29·62
10	...	29·20	...	...	29·40			
11	...	29·22						
Noon.	...	29·24						
1	...	29·25	...	...	...	...	29·51 at 1·15	
2	...	29·26	...	...	29·41			
3	29·19	29·27	...	...	...	29·42	...	29·65
4	...	29·28						
5	...	29·30	...	...	...	...	29·52	
6	...	29·31						
7	...	29·32						
8	...	29·35						
9	29·33	29·37	...	...	...	...	...	29·65
10	...	29·39	...	29·45				
11	...	29·40	29·36					
12								

Barometer, reduced to sea-level.

Hour.	31 October 1863.				1 November 1863.		2 November 1863.	
	Exeter. Lat. 50° 43′ N. Long. 4° 7′ W. 140 ft. above sea.	Little Bridy. Lat. 50° 41′ N. Long. 2° 34′ W. 367 ft. above sea.	Upwey. Lat. 50° 38′ N. Long. 2° 25′ W. 70 ft. above sea.	Guernsey. Lat. 49° 27′ N. Long. 2° 32′ W. 204 ft. above sea.	East Yell. Lat. 60° 33′ N. Long. 1° 3′ W. 176 ft. above sea.	Highfield House. Lat. 52° 58′ N. Long. 1° 10′ W. 174 ft. above sea.	East Yell. Lat. 60° 33′ N. Long. 1° 3′ W. 176 ft. above sea.	Highfield House. Lat. 52° 58′ N. Long. 1° 10′ W. 174 ft. above sea.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1								
2	...	...	...	...	...	...	...	29·01
3	...	...	...	...	...	...	...	28·94
4	...	...	...	...	...	...	...	28·90
5	...	...	...	...	...	...	...	28·88
6	...	...	...	...	...	...	...	28·86
7								
8								
								28·82 at 8.30
9	29·58	29·59	29·60	29·59	29·14	...	29·38	28·83
								28·84 at 9.30
10	...	...	...	...	...	29·53	...	28·93
11								
Noon.								
1								
2	...	...	...	...	...	...	...	28·91
3								
4	29·67							
5	...	...	...	...	...	29·33	...	28·94
								28·93 at 5.30
6	...	...	...	...	...	29·44	...	29·00
7								
8	...	...	...	...	...	...	...	29·22
9	29·66	29·64	29·66	29·73	29·35	29·43	29·46	
10	...	...	...	...	...	...	...	29·50
						29·35 at 10.15		
11								
12	...	...	...	...	...	...	...	29·51

Armagh Observatory.—1863.

Hour.	October 28.		October 29.		October 30.		October 31.	
	Direction of Wind.	Velocity in hour preceding.	Direction of Wind.	Velocity in hour preceding.	Direction of Wind.	Velocity in hour preceding.	Direction of Wind.	Velocity in hour preceding.
		miles.		miles.		miles.		miles.
1	W.S.W.	1·5	S.	11·7	S.W.	19·7	S.W.	37·9
2	W.S.W.	1·1	S. by E.	12·0	S.W.	17·0	S.W. by W.	36·9
3	W.S.W.	3·2	S.E. by S.	12·8	S.W. by S.	18·2	S.W. by W.	35·4
4	W.S.W.	4·4	S.S.E.	8·4	S.W. by S.	18·7	S.W. by W.	38·7
5	W.S.W.	5·0	S. by E.	15·2	S.W. by S.	18·4	W.S.W.	40·5
6	W.N.W.	8·0	S.S.E.	15·3	S.W. by S.	17·7	W.S.W.	37·0
7	N.W.	7·9	S.S.E.	15·5	S.W. by S.	16·0	W.S.W.	26·3
8	N.W.	5·5	E.S.E.	18·5	S.W. by S.	15·7	W. by S.	21·3
9	N.W.	7·3	E.S.E.	26·1	S.W.	17·2	W. by S.	21·3
10	N.W.	5·8	S.S.E.	34·6	S.W.	6·9	S.W. by W.	18·2
11	N.W. by W.	8·1	S. by W.	31·6	S.W. by W.	16·9	W.S.W.	19·0
Noon	N.W. by W.	9·0	S.W. by W.	32·7	S.W. by W.	23·3	W.S.W.	16·0
1	W.N.W.	7·7	W.S.W.	35·6	S.W. by W.	21·5	W.	12·3
2	W.N.W.	8·3	W. by S.	37·0	S.W. by W.	16·6	W. by N.	11·2
3	W. by N.	7·0	W. by S.	35·1	W.S.W.	19·1	W.	11·5
4	W. by S.	5·0	W. by S.	30·4	S.W. by W.	24·8	W.	9·9
5	W.S.W.	6·8	W.S.W.	35·0	S.W. by W.	25·3	W.	7·0
6	W.S.W.	5·8	W. by S.	24·3	S.W.	24·7	W.	6·1
7	S.W.	5·4	W.S.W.	27·8	S.W.	31·2	W.	7·4
8	S.W.	7·0	W.	19·4	S.W.	26·9	W.S.W.	8·1
9	S.W.	6·6	S.W. by W.	21·9	S.W.	27·7	W.S.W.	10·0
10	S.W. by S.	8·2	W. by S.	16·9	S.W. by W.	30·1	W.S.W.	10·8
11	S.S.W.	7·5	S.W. by W.	20·2	S.W.	29·6	W.S.W.	9·7
12	S.S.W.	8·1	S.W. by W.	19·3	S.W.	37·0	W.S.W.	9·5

Birmingham.—1868.

Hour.	October 29.		October 30.		October 31.	
	Direction of Wind.	Greatest Pressure on square foot during preceding hour.	Direction of Wind.	Greatest Pressure on square foot during preceding hour.	Direction of Wind.	Greatest Pressure on square foot during preceding hour.
		lbs.		lbs.		lbs.
1	S.S.E.	......	E. by S.	......	S.W.	2·5
2	S. by E.	......	S.S.E.	......	S.W.	3·2
3	S. by E.	0·9	S.S.E.	......	S.S.W.	4·8
4	S.	......	S.E.	......	S.S.W.	1·9
5	S.	1·0	S.E. by E.	......	S. by W.	4·0
6	S.S.E.	......	S.E.	......	S.	4·6
7	S. by E.	1·3	S. by E.	0·2	S. by W.	10·2
8	S.	2·5	S.	1·2	S.S.W.	10·3
9	S. by E.	2·3	S.	4·1	S.S.W.	16·1
10	S.S.W.	4·0	S. by E.	4·1	S. by W.	18·2
11	S.W. by W.	3·8	S. by E.	8·0	S. by W.	14·0
Noon	S.W. by W.	3·6	S. by E.	7·8	S. by W.	21·3
1	S.W. by W.	4·3	S.	10·1	S.S.W.	7·9
2	W.S.W.	3·7	S.W. by S.	8·9	W. by S. at 1.2 W.	6·0
3	W.S.W.	1·8	S.W.	13·3	W. by N.	3·3
4	S.W. by W.	1·5	S.W. by W.	17·0	W. by S.	2·4
5	S.W. by W.	1·1	S.W. by W.	12·4	S.W. by W.	4·9
6	S.W. by W.	0·7	W.S.W.	12·0	S.W.	6·0
7	N.W.	......	S.W.	7·6	S.W.	3·3
8	N.W. by W.	......	S.W. by W.	7·6	S.W.	3·1
9	N.W.	0·6	S.W.	6·9	S.W.	3·9
10	N.W. by N.	......	S.W.	4·0	S.W. by W.	2·8
11	N.W. by N.	......	S.W. by W.	7·2	S.W. by W.	9·0
12	N.W. by N.	......	S.W.	4·3	S.W.	5·1

Royal Observatory, Greenwich.—1863.

Hour.	October 28.		October 29.		October 30.	
	Direction of Wind.	Greatest Pressure on square foot during preceding hour.	Direction of Wind.	Greatest Pressure on square foot during preceding hour.	Direction of Wind.	Greatest Pressure on square foot during preceding hour.
		lbs.		lbs.		lbs.
1	S.S.W.	......	S. by W.	......	W.S.W.	
2	S.S.W.	......	S.	......	W.S.W.	
3	S.	......	S. by W.	......	W.S.W.	
4	S. by E.	......	S.	......	W.S.W.	
5	S.	......	S.	......	S.W.	
6	S.	......	S. by E.	......	S.S.W.	
7	S.	......	S.W. by S.	......	S.W. by W.	
8	S. by E.	......	S.W. by S.	......	W.S.W.	0·5
9	S. by W.	......	S.S.W.	......	W. by S.	3·1
10	S.W. by S.	......	S.S.W.	......	W. by S.	14·9
11	S.W. by W.	......	S.S.W.	......	W.S.W.	3·0
Noon	S.W.	......	S. by W.	2·3	W.S.W.	3·2
1	S.W. by S.	......	S.W. by S.	3·8	S.W. by W.	3·5
2	S.W.	......	S.W. by S.	4·0	S.W. by W.	5·2
3	W.	......	S.W. by S.	4·2	S.W. by W.	5·0
4	W. by S.	......	W.S.W.	13·8	N.W. by N.	29·5
5	W. by S.	......	W.S.W.	3·1	W.N.W.	7·9
6	W.S.W.	......	W. by S.	4·7	W.	3·0
7	S.W.	......	W.S.W.	2·2	W. by S.	2·1
8	S.W.	......	W.S.W.	1·4	W. by S.	3·2
9	W.S.W.	......	W.S.W.	1·4	W. by S.	3·4
10	S.W. by S.	......	W.S.W.	3·5	W.S.W.	1·3
11	S.S.W.	......	W.S.W.	1·3	W. by S.	2·8
12	S. by W.	......	W.S.W.	0·9	W. by S.	1·3

Liverpool Observatory.—1863.

Hour.	October 29. Direction of Wind.	October 29. Greatest Pressure on square foot during preceding hour.	October 30. Direction of Wind.	October 30. Greatest Pressure on square foot during preceding hour.	October 30. Velocity in hour preceding.	October 31. Direction of Wind.	October 31. Greatest Pressure on square foot during preceding hour.
		lbs.		lbs.	miles.		lbs.
1	S.S.E.	0·5	W.S.W.	9·0	34	S.W.	3·6
2	S.S.E.	0·4	S.S.W.	4·1	22	S.S.W.	4·4
3	S.S.E.	0·3	S.S.W.	1·6	17	S.S.W.	5·0
4	S.E.	0·6	S.	3·1	18	S.W. by S.	6·6
5	S.E.	0·8	S.S.E.	2·6	18	S.W. by S.	9·2
6	S.E.	1·6	S.S.E.	2·6	17	S.W.	11·6
7	S.E.	1·8	S.S.E.	3·0	18	S.W.	12·0
8	S.E.	2·5	S.E. by S.	3·2	18	S.W.	12·9
9	S.E. by E.	2·9	S.	3·1	18	S.W. by W.	13·5
10	S.E. by E.	4·0	W.S.W.	3·4	18	S.W. by W.	19·7
11	S.S.E.	7·5	W.	4·0	20	S.W.	13·6
Noon	S.S.E.	9·8	W.	2·6	15	S.W.	10·6
1	S.S.E.	12·7	W.S.W.	1·5	13	S.W. by S.	9·4
2	S.S.W.	11·7	S.W. by W.	2·0	15	S.W.	7·5
3	S.W. by S.	13·4	S.W.	2·8	21	S.W. by W.	6·1
4	W.S.W.	15·0	W.S.W.	3·6	28	S.W. by W.	4·9
5	W.S.W.	12·5	W.S.W.	14·2	27	W.S.W.	5·0
6	S.W.	14·6	W. by S.	11·0	37	W.S.W.	6·3
7	W.S.W.	19·0	W.S.W.	9·1	32	W.S.W.	3·3
8	W.S.W.	19·1	W.S.W.	10·2	33	W.S.W.	5·1
9	W.S.W.	12·9	S.W.	7·2	28	W.S.W.	5·2
10	W.S.W.	13·6	S.W.	3·0	22	W.S.W.	4·0
11	W.S.W.	13·1	W.S.W.	9·2	36	W.	2·6
12	W.S.W.	11·2	W.S.W.	11·4	36	W. by N.	6·2

Hour.	Glasgow Observatory, 1863.	Radcliffe Observatory, Oxford.—1863.						Wrottesley Observatory.—1863.		
	October 29.	October 28.		October 29.		October 30.		October 30.		
	Greatest Pressure on square foot during preceding hour.	Direction of Wind.	Bi-hourly Velocity.	Direction of Wind.	Bi-hourly Velocity.	Direction of Wind.	Bi-hourly Velocity.	Direction of Wind.	Greatest Pressure on square foot during preceding hour.	Velocity in hour preceding
	lbs.		miles.		miles.		miles.		lbs.	miles.
1	0·5									
2	0·8	....	....	S. by W.	1	S.	36			
3	0·7									
4	2·5	....	....	S.E.	6	S.	25	S.	1·2	
5	3·6	....	....	....	....	....	....	S.	1·8	7
6	2·2	....	....	S.S.E.	18	S.E. by S.	?	S.	3·3	9
7	2·7	....	....	....	....	....	....	S. by W.	4·6	12
8	3·1	....	....	S.S.E.	19	S.	33	S.	7·5	12
9	3·6	....	....	....	....	....	....	S.S.W.	10·6	16
10	4·3	....	....	S.E.	28	S.	49	S.	7·3	13
11	7·0		....	....	....	....	....	S.	7·0	12
Noon	6·8	S.S.W.	....	S.S.W.	41	S.S.E.	41	S. by W.	6·4	12
								W. by N. at 0.15		
1	11·0	....	....	....	....	....	....	W.N.W.	3·2	9
2	9·8	W.S.W.	22	S.S.W.	44	S.S.W.	36	W.N.W.	2·8	8
						W. by N. at 2.25				
3	11·8	....	....	....	....	....	....	W.	1·5	4
4	11·5	W. by N.	13	S.S.W.	58	S.W. by W.	46	W. by S.	1·7	6
5	12·6	....	....	....	....	....	....	W.S.W.	4·1	9
6	......	W.S.W.	7	S.S.W.	43	S.S.W.	31	S.W. by W.	9·0	11
7	......	....	....	....	....	....	....	S.W. by W.	2·9	9
8	......	S.W.	5	S.	43	S.S.W.	32	S.W. by S.	2·0	7
9	31·0	....	....	....	....	....	....	S.W. by S.	1·1	4
10	24·9	S.W.	5	S.	31	S.	36	S.W.		
11	22·8									
12	12·7	S.W.	1	S.	36					

Temperature.—1868, October.

Hour.	Royal Observatory, Greenwich. Dry-bulb thermometer.			Radcliffe Observatory, Oxford, Dry-bulb thermometer.	Highfield House Observatory, Nottingham. Dry- and Wet-bulb thermometers.							
	28.	29.	30.	30.	28.		29.		30.		31.	
	°	°	°	°	°	°	°	°	°	°	°	°
1	47.1	45.8	45.4	....	....		36.1	35.1	39.1			
2	46.8	45.4	45.0									
3	46.3	45.8	44.8	....	....		....		44.1			
4	46.9	46.7	44.7	....	....		34.8	34				
5	47.6	46.6	44.3	....	....		....		47.5			
6	46.9	46.0	43.9	44.1	....		36.7	35.7				
7	47.4	46.1	46.4	49.2	....		39.5	36.6				
8	49.3	46.4	48.5	49.3	....		42.	39.9				
9	50.9	47.5	50.3	49.5								
10	52.0	48.8	49.4	49.5	47.4	46.0	43.	38.8	50.5	45.7	48.5	42.5
11	53.9	50.0	50.2	49.4	....		48.2	45.4				
Noon	55.7	51.0	49.8	49.8	....		48.9	46.1				
1	53.6	51.9	51.0	50.6	....		50.	48.3				
				51.5 at 1.50								
2	52.9	52.7	51.7	50.0	....		52.	50.1				
3	51.7	53.8	52.2	43.6								
			53.2 at 3.20									
4	51.4	52.2	46.0	42.5								
5	49.9	51.1	43.4	41.5	....		50.2	46.6				
6	47.4	48.6	42.0	41.4	....		49.1	45.4				
7	48.5	47.0	41.8	41.5	....		48.7	45.				
8	46.3	46.0	41.5	40.7								
9	46.7	45.8	40.6	40.8								
10	46.4	46.0	40.5	40.9	37.4	36.2	42.6	39.	38.3	36.5	44.5	42.2
11	46.1	45.6	40.5	41.0								
12	46.1	45.9										

Temperature.—1863, October (*continued*).

	Date.	9 A.M. Dry-bulb.	9 A.M. Wet-bulb.	Noon. Dry-bulb.	Noon. Wet-bulb.	3 P.M. Dry-bulb.	3 P.M. Wet-bulb.	6 P.M. Dry-bulb.	6 P.M. Wet-bulb.	9 P.M. Dry-bulb.	9 P.M. Wet-bulb.
		°	°	°	°	°	°	°	°	°	°
East Yell	29	46·0	...	...	...	...	...	...	...	48·0	
	30	42·8	...	...	...	...	...	...	...	45·0	
	31	48·0	...	...	...	...	...	...	...	49·0	
Sandwick	29	40·8	39·1	...	...	...	...	...	...	44·9	44·0
	30	40·0	37·9	...	...	...	...	...	...	38·5	37·2
	31	41·5	39·2	...	...	...	...	...	...	43·0	40·1
New Pitsligo	29	39·0	...	...	...	...	...	...	...	44·0	
	30	38·2	...	...	...	...	...	...	...	39·7	
	31	39·8	...	...	...	...	...	...	...	42·0	
Portree	29	43·0	...	...	...	...	...	...	...	39·2	
	30	40·0	...	...	...	...	...	...	...	41·0	
	31	42·4	...	...	...	...	...	...	...	40·0	
Montrose	29	44·5	...	...	...	...	...	...	...	46·0	
	30	44·0	...	...	...	...	...	...	...	43·5	
	31	42·5	...	...	...	...	...	...	...	45·0	
Balfour	29	44·0	...	...	...	...	...	...	...	45·0	
	30	44·0	...	...	...	...	...	...	...	43·5	
	31	45·5	...	...	...	...	...	...	...	45·0	
Glasgow............	28	45·0	42·8	...	...	...	...	...	...	37·8	37·4
	29	40·3	40·0	...	...	...	...	...	...	41·0	39·6
	30	39·9	37·8	...	...	...	...	...	...	40·6	37·8
	31	42·8	41·0	...	...	...	...	...	...	39·6	38·5
Silloth	29	42·0	40·0	...	...	...	...	...	...	44·0	39·8
	30	41·4	40·0	...	...	...	...	...	...	45·0	40·0
	31	46·1	44·0	...	...	...	...	...	...	44·5	42·1
Wakefield	29	41·0	41·0	...	...	52·0	48·5	...	...	42·0	40·0
	30	46·5	46·5	...	...	40·5	40·5	...	...	44·0	43·0
	31	44·0	42·7	...	...	46·7	45·0	...	...	43·0	43·0
Liverpool	30	45·9	44·9	1 P.M. 43·3	41·7	44·8	42·1	...	...	42·7	39·7
Wrottesley..........	29	43·2	42·4	...	...	50·1	45·2				
	30	47·0	44·0	...	...	40·0	39·0				
	31	43·9	40·0	...	...	46·7	41·6				
Norwich............	29	50·0	48·0	50·7	48·0	53·0	51·0	50·9	50·0	44·0	43·0
	30	47·0	44·5	51·3	46·5	51·0	50·0	44·0	43·0	41·0	39·0
	31	45·8	43·2	51·5	48·0	48·3	45·0	46·0	43·3	45·0	43·0

Temperature.—1863, October (*continued*).

	Date.	9 A.M. Dry-bulb.	9 A.M. Wet-bulb.	Noon. Dry-bulb.	Noon. Wet-bulb.	3 P.M. Dry-bulb.	3 P.M. Wet-bulb.	5 P.M. Dry-bulb.	5 P.M. Wet-bulb.	9 P.M. Dry-bulb.	9 P.M. Wet-bulb.
		°	°	°	°	°	°	°	°	°	°
Clifton	29	47·2						46·7			
	30	51·0	...	...	...	...	...	43·9			
	31	46·4						44·0			
Little Bridy	28	50·5	50·0	...	...	...	...	...	...	46·5	46·0
	29	50·0	49·6	...	...	...	...	...	...	47·0	44·9
	30	49·6	48·7	...	...	...	...	...	...	41·3	40·2
	31	48·1	46·9	...	...	...	...	...	...	46·2	42·1
Upwey	28	51·8	51·0	...	...	...	...	...	...	47·8	47·2
	29	51·4	50·1	...	...	...	...	...	...	48·1	44·7
	30	51·0	49·6	...	...	...	...	...	...	41·4	39·7
	31	50·2	45·4	...	...	...	...	...	...	46·4	42·3
Exeter	29	50·0	48·5	...	...	49·0	45·0				
	30	48·7	47·7	...	...	44·5	41·3				
	31	47·0	43·0	...	...	48·0	43·5				
Truro	29	52·0	50·0	...	...	50·0	47·0	...	...	47·0	45·0
	30	51·0	50·0	...	...	47·0	44·0	...	...	45·0	43·0
	31	47·0	44·0	...	...	50·0	46·0	...	...	46·0	43·0
Guernsey	29	53·0	50·0	...	...	52·0	48·0				
	30	53·0	50·0	...	...	53·0	50·0				
	31	49·0	45·0	...	...	49·0	45·0				
Leckpatrick	28	43·0	41·0								
	29	43·0	42·0								
	30	37·0	35·0								
	31	43·0	42·0								
		10 A.M.								10 P.M.	
Armagh	28	44·2	41·6							39·3	37·9
	29	45·8	44·6	...	...	...	...	...	...	37·0	35·4
	30	41·1	38·0							38·3	37·0
	31	44·3	43·7							37·1	36·9

Note.—The Latitudes and Longitudes of New Pitsligo, Portree, Stronvar, South Cairn and were not precisely known by the author when the first sheet of this paper went to press, and are incorrectly stated on pages 131 and 132; the true values are subsequently given on the pages following these.

M 2

LVII. *Climate of Gangaroowa, near Kandy, Ceylon.*

By H. H. Harnes, Esq. Communicated by L. P. Casella, Esq.

1862. Month.	Barometer reduced to 32°. A.M. 9.30	Barometer reduced to 32°. P.M. 3.30	Thermometer. A.M. 9.30	Thermometer. P.M. 3.30	Dew-point. A.M. 9.30	Dew-point. P.M. 3·30	Maximum in Air.	Minimum in Air.	Mean.	Distance in Miles, in twenty-four hours.	No. of days Lightning seen.	No. of days Thunder heard.	Rain-gauge 4½ feet above ground. A.M. 9.30	Rain-gauge 4½ feet above ground. P.M. 10.0	Rain-gauge 4½ feet above ground. Total.
	in.	in.	°	°	°	°	°	°	°						
Jan.	28·392	28·273	73·7	77·0	67·0	69·1	77·3	66·6	72·0	...	7	4	1·660	6·072	7·732
Feb.	·379	·257	73·1	77·2	66·5	68·3	77·4	64·5	71·0	...	4	3	1·553	2·643	4·196
March	·398	·269	75·0	79·8	67·7	68·2	80·2	65·5	72·9	...	14	12	0·150	7·934	8·084
April	·360	·239	77·3	81·1	70·2	72·0	81·6	68·4	75·0	...	14	13	0·078	2·264	2·342
May	·346	·241	77·6	79·9	71·6	73·4	80·9	68·8	74·9	...	13	9	0·063	7·980	8·043
June	·300	·217	77·0	78·8	71·0	72·4	79·0	69·9	74·5	39·44	9	4	1·009	3·828	4·837
July	·312	·222	75·4	77·0	71·1	72·5	77·5	70·2	73·9	31·57	4	2	1·209	3·788	4·997
Aug.	·352	·257	74·9	76·5	70·9	71·9	77·3	69·0	73·2	46·34	2	0	2·719	6·055	8·774
Sept.	·336	·226	74·7	76·1	71·2	72·4	77·0	69·0	73·0	43·05	9	7	5·237	9·834	15·071
Oct.	·345	·233	75·8	77·6	70·7	72·3	78·6	67·8	73·2	24·15	17	11	0·902	7·630	8·532
Nov.	·349	·236	75·1	76·5	70·8	72·6	77·8	67·9	72·9	13·22	19	16	2·195	15·217	17·412
Dec.	·319	·204	73·5	75·3	70·3	72·1	75·8	67·5	71·7	11·66	8	7	6·060	10·246	16·306
Means and Totals	28·349	28·239	75·3	77·7	69·9	71·4	78·4	67·9	73·2	29·92	120	88	22·835	83·491	106·326

1863. Month.	Amount of Cloud. A.M. 9.30	Amount of Cloud. P.M. 3.30	Wind—Mean Direction. By Vane. A.M. 9.30.	Wind—Mean Direction. By Vane. P.M. 3.30.	Wind—Mean Direction. By Lower Clouds. A.M. 9.30.	Wind—Mean Direction. By Lower Clouds. P.M. 3.30.	Compared with average of eight years.	Number of Days.	Dew on piece of flannel. Grains per square foot.	Dew on piece of flannel. No. of days.
Jan.	6·2	6·5	N.E.	N. by E.	E.N.E.	E.N.E. ½ E.	+ 4·032	18		
Feb.	4·4	6·9	E.N.E.	N.E. by N.	E. ½ N.	E.N.E.	+ 2·539	11		
March	3·7	6·0	S.S.W.	N. by E.	?	?	+ 4·007	14	6,892	29
April	2·7	5·4	S.W. by S.	W.N.W.	S.S.W. ½ S.	E.S.E.	− 6·028	9	5,520	27
May	6·4	7·2	W.S.W.	W.	S.W. ½ S.	W.S.W. ½ S.	+ 1·863	13	5,904	25
June	8·0	8·1	W. by S.	W.	W.S.W.	W.S.W. ½ W.	− 1·993	21	2,965	15
July	8·7	9·0	W.S.W.	W. by S.	W.S.W. ½ S.	W.S.W.	− 0·518	27	981	8
Aug.	8·9	8·8	W.S.W.	W. by S.	W.S.W. ½ S.	W.S.W.	+ 1·024	26	2,558	12
Sept.	8·6	9·0	W.S.W.	W. by S.	W.S.W. ½ S.	W.S.W.	+ 8·894	29	938	7
Oct.	8·7	8·8	W.S.W.	W. by S.	S.W. by W.	W.S.W.	− 7·942	25	3,286	17
Nov.	7·1	9·6	N. by W.	S.W.	N.E. by N.	N. by E.	+ 3·288	27	3,483	16
Dec.	8·0	9·1	N.N.W. ½ W.	N.W.	N.	N. by W.	+ 8·775	27	2,795	13
Means and Totals	6·8	7·9	......	......	......	......	+17·942	247	35,322	169

Climate of Gangaroowa (*continued*).

Barometer highest at 9.30	28·471	on December 31.
„ „ 3.30	28·348	on January 15.
„ lowest at 9.30	28·168	on December 18.
„ „ 3.30	28·069	„ 18.
Thermometer highest maximum	84·2	on April 20.
„ lowest minimum	49·0	on January 14.
Greatest amount of rain from 10.0 P.M. to 10.0 P.M.	3·420	on November 10.

35,322 grains of dew = 0·970 inch in depth.

	Dry.	Wet.	Dew-point.
Greatest observed difference between temperature and dew-point on March 4, 2.35 P.M., 36°·1	82·8	61·9	46·7
Corresponding humidity	300		

Gangaroowa [near Kandy, Ceylon.]

Altitude 1560 feet. E. long. 80° 37′; N. lat. 7° 17′ 0″.

SUNDRY NOTES.

20. *Severe Weather.*—Letters from the south of France are filled with accounts of the severe weather which has prevailed there for some days past. A railway-train was stopped on Saturday afternoon, near Narbonne, in consequence of the vast quantity of snow which had fallen; and it became necessary to call for the assistance of the troops of the garrison to clear the snow away. Snow had fallen near Beziers for thirty-eight hours without ceasing. It lay on the ground to the depth of nearly 2 feet, and rendered it impossible for carriages to travel either on the highroads or railways. All the railway-trains due at Lyons on Saturday arrived late, and it became necessary to suspend the despatch of any from that city. Snow fell for thirty-six hours, without intermission, at Valence, on the Rhone, accompanied with violent wind. All communication had been stopped between Lyons and Marseilles for several hours. At Privas, communication with the neighbouring villages by men or horses was rendered impossible from the mass of snow on the ground, and it became necessary to suspend the drawing for the conscription. It appears that the wheat-crop has not suffered; but beans and rape have not escaped injury. The ground having been chilled by the late frost, vegetation is checked in the south. Farmers console themselves with the hope that when spring sets in they will not have to dread the return of winter, which, succeeding fine weather too early in the season, frequently destroys crops in one night.

Accounts from the Department of the Loire state that, after two or three days' hard frost, the temperature had become considerably milder, and it was believed that there was an end of the bad

weather. Snow, however, soon began to fall, and on Saturday last the thermometer marked 5° below freezing-point. A piercing north wind rose, and the streets of Montbrison were covered with a thick coat of ice, which made them unsafe for travellers. Winter had already lasted there for fully two months—a fact almost unprecedented in that district.—*Times*, Feb. 25, 1864.

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21. *Prospective Weather.*—M. Mathieu de la Drome, of weather-wise celebrity, has just addressed a letter to the Marseilles papers, in which he reminds them that, on the 10th of January, he announced that the first four months of the present year would be remarkable for the inclemency of the weather, which would particularly affect the coast of the Mediterranean. He announced, so far back as the 10th of October, that storm, rain, and snow would be experienced in the month of February—an announcement confirmed by the late previously unheard-of stoppage of railway-trains in Provence by repeated snow-storms. He now adds that the high winds habitual to the month of March will be principally experienced in the Mediterranean and in the Gulf of Gascony towards the 4th, 11th, 16th, and 18th of that month. The winds which will begin to blow from the 16th to the 18th will be the most violent and the most dangerous. It will be otherwise on the north-west of France and on the coast of the Channel; for bad weather is particularly to be feared there in the beginning of the month of March. He concludes by stating that he publishes his letter in the interest of seafaring people.—*Times*, February 29, 1864.

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22. *Admiral FitzRoy's Forecasts.*—Mr. Augustus Smith asked the President of the Board of Trade whether any observations had been made for the purpose of recording the actual weather corresponding to Admiral FitzRoy's daily forecasts and occasional warning-signals; and if so, whether there would be any objection to lay the results before the House.

Mr. M. Gibson said, observations had been made, and comparisons instituted, between the actual weather and the predictions of Admiral FitzRoy; and they were endeavouring to digest the results, and put them into a shape which should be intelligible to the House. When that was done, and Admiral FitzRoy had got an opportunity of seeing the comparisons and making his remarks upon them, they should be happy to present them for the information of the House (*Hear, hear*). They had received a similar comparison made by the French, which they would also communicate to the House. —*Parliamentary Intelligence*, 'The Times,' March 12, 1864.

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

VOL. II. 1864, MARCH 16. [No. 12.

R. DUNDAS THOMSON, Esq., M.D., F.R.S. L. & E., President, in the Chair.

Alexander Beattie, Esq., J. P. (Kent and Sussex), 25 Warrior Square, St. Leonard's-on-Sea;
Louis J. Crossley, Esq., Dean Clough, Halifax;
were balloted for and duly elected Members of the Society.

The names of Six Candidates for admission into the Society were read, and ordered to be suspended.

The following gentlemen, who had been duly elected Members, subscribed the Form No. 2, and were admitted into the Society:—

	Elected
William Blundell, Esq., M.R.C.S.	1864, February 17.
Lieut.-Col. Alexander Strange, F.R.A.S. ...	1863, June 17.
Clarence E. Trotter, Esq.	1864, February 17.

LVIII. *Computation of the Dew-point from the Readings of Wet and Dry Thermometers.* By J. C. BLOXAM, Esq.

MR. GLAISHER'S Table IX., in his account of the balloon ascents published in the last Report of the British Association, contains a column for the differences between the dew-point as read from Daniell's hygrometer, and as calculated from the readings of the dry and wet thermometers. We have here a test of the correctness of the means used for calculating the temperature of the dew-point from

the readings of the dry and wet thermometers, or Mason's hygrometer. All parts of the Table are not equally serviceable for the purpose: at great heights, it naturally happens that the observations are not numerous, and, whilst they diminish in number, they become more irregular and discordant one with another. The groups between 10,000 and 21,000 feet contain only thirteen values, and these differ greatly amongst themselves. By taking into account all the values up to 10,000 feet, it appears that the dew-point deduced from Mason's hygrometer is a trifle in excess of that indicated by Daniell's hygrometer; but there are only two comparisons between 7000 and 10,000 feet, and whilst one of these gives $+5^{\circ}\cdot1$, the other gives $-0^{\circ}\cdot8$. The seven lowest groups (up to 7000 feet) give us one hundred values to deal with, and the whole range, here, is from $+4^{\circ}\cdot7$ to $-4^{\circ}\cdot8$. The mean of the plus values just exceeds the mean of the minus values. The plus values belong more especially to the lower levels, and the minus values to the upper; each of the four lowest groups (up to 4000 feet) gives a plus mean value, and the mean for the four groups is $+0^{\circ}\cdot8$; each of the three upper groups gives a minus value, and the mean for the three is $-0^{\circ}\cdot9$. There are fifty-one values included in the lower division of groups, and forty-nine in the upper division. The range is from $+4^{\circ}\cdot7$ to $-3^{\circ}\cdot8$ in the lower, and from $-4^{\circ}\cdot8$ to $+3^{\circ}\cdot3$ in the upper. Thus there are consistent and satisfactory data to deal with within the range of 7000 feet; and these imply, first, that the formula used for *calculating* the dew-point gives a value too high at such levels as observations are more commonly made at—or within 4000 feet; and the excess here indicated amounts to $0^{\circ}\cdot8$. This amount, however, can only be accepted as belonging to the period of the year in which the experiments were made, or rather to the hygrometrical condition which belongs to that period of the year, that is to say, August and September. In the 'Meteorology of Newport' (p. 8) a Table of corrections, deduced from a series of observations, for the calculated dew-point, is given for each month in the year; and the correction given for August and September is $-0^{\circ}\cdot8$. Secondly, it appears that the *same* correction is not applicable to *different* heights: the formula which serves to make the calculated dew-point correspond with the reading of the hygrometer at low levels will make it too low at higher levels. This is what might be expected, as air-pressure would *impede* evaporation, though it would not prevent it.

LIX. *Monthly Meteorological Table of Observations taken at Lagos, Africa, for the Half-year ending December 31st,* 1863. By CHARLES D. TURTON, Esq.

Level with the sea. Lat. 6° 12′ N.; Long. 3° 25′ E.

Year 1863.	Pressure of Atmosphere in Month.		Temperature of Air in Month.						Mean Temperature.	
						Mean				
Month.	Mean.	Range.	Highest.	Lowest.	Range.	Of all highest.	Of all lowest.	Daily Range.	Air.	Dew-point.
	inches.	inch.	°	°	°	°	°	°	°	°
June	29·974	0·102	89·0	...	...	...	...	...	78·2	75·3
July	30·011	0·136	87·1	68·5	18·6	82·9	71·8	11·1	76·6	73·0
August	30·047	0·132	87·0	67·0	20·0	84·2	70·9	13·3	75·5	72·9
September......	30·001	0·106	91·0	66·5	24·5	86·8	71·0	15·8	77·7	76·3
October	29·950	0·140	91·0	67·0	24·0	86·5	72·4	14·1	78·0	77·1
November	29·925	0·116	94·0	68·0	26·0	90·3	71·5	18·8	80·2	78·5
December	29·955	0·104	96·5	65·0	31·5	93·5	71·1	22·4	80·6	78·5

Month.	Vapour.			Mean Degree of Humidity. Saturation 100.	Mean Weight of a Cubic Foot of Air.	Mean Reading of Thermometer.		Rain.	
		In a cubic foot of Air.							
	Elastic Force.	Mean.	Short of Saturation.			Maximum in Rays of Sun.	Minimum on Grass.	No. of Days it fell.	Amount collected.
						°	°		
June	0·877	9·5	0·9	85	512	...	69·9	11	11·75
July	0·812	8·8	1·2	89	515	113·0	69·1	16	15·97
August	0·810	8·8	0·8	91	516	120·4	68·0	6	1·34
September......	0·906	9·9	0·4	95	513	125·8	68·5	6	1·82
October	0·930	10·3	0·3	97	512	118·7	63·0	13	17·33
November	0·974	10·5	0·5	96	509	121·6	68·7	7	1·97
December	0·974	10·5	0·6	94	509	132·7	67·0	3	10·14

No return is made of Wind, Cloud, or Ozone.

JUNE.

Throughout this month the wind varied from S.W. to W., with strong breezes during the day, which, in some instances, continued

through the night, and very cold. The times of commencement very irregular; but upon the average from 9h or 10h A.M., and when not continued throughout the night, generally died away about 11h P.M. Rain at intervals, but not very heavy; the wind accompanying it was strong, and very cold.

Thunder heard several times; but saw no lightning.

The bar of the river very good for this month, but medium current to the eastward. Palm-trees beginning to blossom.

July.

Wind from S.W. to W., in strong breezes through the day, sometimes continuing throughout the night. From the 22nd, the wind generally died away about 10h P.M., excepting a few days when it blew lightly all the night. Very heavy rains at the early part of the month. No thunder or lightning. Upon the whole, the sky has been dark and cloudy; occasional glimpses of sunshine, but never continued the whole day. The bar, though bad for a few days, has been considered, taking all in all, very good for the time of the year, which is the worst here. The current to the eastward has been running so strong, that boats could not pull or sail against it, and have, consequently, been driven down to Palma, run on shore there and broken; one boat, capsized on the bar, was completely broken, and the Krooman saved with difficulty. I do not think, out of the whole month, boats have worked more than ten days. Fever and dysentery very prevalent. Country very unsettled.

August.

Wind same as last month; if any change, it has been more westerly, and at times very cold and chilly, especially towards evening. Cloudy at times, but, on the whole, clear sky and hot in the sun. No thunder or lightning has been heard or seen. Bar has been very bad almost the whole month, in many cases quite impassable by boats. Lieut. Dolben, of H.M.S. 'Investigator,' was drowned returning from the Commodore's ship 'Rattlesnake,' caused by his gig upsetting on the bar. Fever and dysentery still very prevalent. Country still very unsettled, and no trade doing with the interior. Oil-season finished. Cotton coming up in Porto Novo only wants rain to make a good crop.

November.

Bar of the river, on average, good. Foggy mornings after the

first week. At times the fog was as thick as a London fog, but was of a much whiter colour, and, when inhaled freely, tickled the throat. Very heavy dews at night: two travelling-rugs put out were wet through in three hours. Fog comes on like smoke at first; about 7 o'clock (before it is quite clear) it can be seen distinctly, and felt the moment it touches the observer. It generally clears away at 8^h A.M., but sometimes at 9^h and 10^h. The currents on the coast not quite so strong, and a tendency to run to the westward is observed. Fever and dysentery prevalent. Place, on the whole, not particularly healthy.

December.

Bar of the river, on average, very good. The harmattan, a very cold dry wind, which blows from the N.E., commenced on the 17th, and has continued off and on ever since. The force has only once reached 2; other times it has been very light.

Fever very prevalent; almost every one sick with it. At night, after 7 o'clock, generally calm. Land-breeze setting in early in the morning. Sea-breeze generally commenced at 11^h A.M., but was not in full force till 1 P.M. The intervals between the departure of land and arrival of sea-breezes were calms, and very hot and sultry atmosphere prevailed.

New Indian corn ripens at the beginning of this month. Trees also lose their leaves, some being perfectly bare. The grass has assumed a yellowish-brown colour, and seems quite parched.

LX. *Description of a Portable Anemometer of moderate cost.* By Mr. Adie.

Almost by universal consent, meteorologists have, of late years, adopted the Robinson cup-anemometer as the best indication of wind-quantities for meteorological purposes.

This arises doubtless from the fact that the form in which it gives its results is most analogous to the form into which all meteorological observations are reduced for working-purposes, viz. either to aggregate or mean—a form into which there is great labour in reducing the results given by all the plate-anemometers hitherto in use, independently of the greatly more uncertain character in many respects of the plate or force instruments.

This instrument, which I have been asked to describe to-night

to the Meteorological Society, is in some degree a new form of the instrument, and scarcely I think merits a separate description, or at least can only claim a description three letters long, seeing the £ *s*. *d*. qualification is the only one of which it can boast; for should its qualities be in the same ratio as its costliness, then it is only one-third as good as its predecessors, now flourishing on the domes of many of the principal Continental observatories. But it is to be hoped that it will in some degree fill the gap that has long been open, *i.e.* of bringing this effective form of instrument within the means of many keen observers, unwilling or unable to cope with the cost of the larger ones.

The diagrams on the table are a proof of this, being the copy of a fragment of the daily observations taken by a civil engineer resident in Smyrna, who, if he had not got that instrument, would probably, or I think certainly, never have gone to the trouble and expense of the larger instrument.

The larger instrument, or Kew Observatory Anemometer, which this represents almost exactly on a reduced scale, has been well described and drawn in the 'Report of the British Association' for 1858, p. 306, by Mr. Robert Beckley, to whom the whole merit of the arrangement is due, as the markers and all the details of this instrument are exactly similar, except that the rates of the pitching-gear are of course altered to suit the shorter arms, and one revolution of the velocity-marker represents ten miles instead of fifty as on the larger paper, this of course, with the design of preserving the openness of the scale. The fixing is intended to be done in either of two ways,—that is, when practicable, passing the short stem through the roof with a bracket inside, or enclosing all the registering portion in a box, which can be placed on any good site, the top of the box acting as a steadier of the stem.

LXI. *Movement of the Air, from January* 31*st*, 1863, *to January* 31*st*, 1864, *as recorded at the Beeston Observatory by the "Atmospheric Recorder*." By E. J. LOWE, F.R.A.S.

IN the accompanying Tables, which are intended to show the number of degrees of movement of the air, direct and retrograde, i. e. *with* or *against* the sun's apparent motion, movements less than 10° have not been included. It has been thought desirable to exclude these small movements, as they partake more of the

character of oscillations about a certain direction than actual changes.

Table I. gives the amount of *direct* movement for each of the 365 days.

Table II. that of the *retrograde* movement for the same period.

Table III. the sign of the day, whether + (direct), – (retrograde); = (where the direct and retrograde movements are equal), or 0 (when there is no movement).

On referring to Table I., it will be seen that the *direct* movement in twenty-four hours exceeded 100°,

In February...	6 times.	August.........	5 times.
„ March	2 „	September ...	4 „
„ April	7 „	October	5 „
„ May.........	7 „	November......	4 „
„ June	6 „	December......	8 „
„ July.........	6 „	January	15 „

Exceeded 200°,

In February, once.	In September, once.
„ April, once.	„ November, twice.
„ May, 5 times.	„ December, 8 times.
„ August, once.	„ January, 8 times.

Exceeded	Exceeded
1000° on 23rd of May.	600° on 22nd of November.
400 on 24th of May.	700 on 3rd of December.
300 on 31st of August.	400 on 28th of December.
300 on 10th of November.	300 on 18th January.

That the total number of degrees of direct movement was,

In January	3323°	In June	1357°
„ May	3285	„ October	1444

being most in January, and least in June.

That the average direct movement in the twenty-four hours was,

In February	55°·4	In August	57°·2
„ March	51·7	„ September......	36·6
„ April...........	57·1	„ October.........	46·6
„ May	106·0	„ November......	58·6
„ June	45·2	„ December	95·7
„ July	56·5	„ January.........	107·2

the total number of revolutions of direct movement being,

In February	4¼	In August	5
„ March	4½	„ September	3
„ April	4¾	„ October	4
„ May	9¼	„ November	5
„ June	3¾	„ December	8¼
„ July	4¾	„ January	9¼

Total, year, 65¾.

On referring to Table II. it will be seen that the *retrograde* movement in twenty-four hours exceeded 100°,

In February...	4 times.	In August ...	2 times.
„ March	6 „	„ September	5 „
„ April	3 „	„ October ...	3 „
„ May.........	4 „	„ November	4 „
„ June	10 „	„ December	5 „
„ July.........	6 „	„ January ...	14 „

Exceeded 200°—

In March, once.	In October, once.
„ May, 4 times.	„ November, twice.
„ June, 4 times.	„ December, 3 times.
„ July, once.	„ January, 6 times.
„ September, once.	

Exceeded	Exceeded
1100° on 23rd of May.	400° on 12th of June.
400 on 24th of May.	300 on 22nd of July.
300 on 11th of June.	700 on 2nd of December.

That the total number of degrees of retrograde movement was—

In January	3175°	In April	874°

That the average *retrograde* movement in twenty-four hours was,

In February	43°·1	In August	33°·6
„ March	50·9	„ September......	46·3
„ April	29·1	„ October.........	45·9
„ May	89·4	„ November......	39·5
„ June	85·2	„ December	82·0
„ July	50·7	„ January.........	102·4

the total number of revolutions of retrograde movement being,

In February	$3\frac{1}{4}$	In August............	3
„ March	$4\frac{1}{2}$	„ September	$3\frac{3}{4}$
„ April..............	$2\frac{1}{2}$	„ October	4
„ May	$7\frac{3}{4}$	„ November.........	$3\frac{1}{2}$
„ June..............	7	„ December.........	7
„ July	$4\frac{1}{4}$	„ January	$8\frac{3}{4}$

Total, year, 59.

Table III. almost explains itself. In August there were 16 days of direct movement in excess of retrograde, and in September only 7. In June there were 16 days of retrograde movement in excess of direct, and in August only 5. In the whole twelve months there were 137 days with excess of direct movement, 122 days with excess of retrograde movement, 43 days in which the direct and retrograde movement were equal, and 63 days in which the direction of the wind did not alter.

	Direct Movement in revolutions.	Retrograde Movement in revolutions.	Excess or defect.
February ...... March	8·7	7·7	+1·0
April .... May	14·0	10·2	+3·8
June .... July	8·5	11·2	−2·7
August .... September	8·0	6·7	+1·3
October .... November	9·0	7·2	+1·8
December ...... January.........	17·5	15·7	+1·8

The number of direct revolutions in the year was $65\frac{3}{4}$.

The number of retrograde revolutions in the year was 59.

Direct movement $6\frac{3}{4}$ revolutions in excess of retrograde movement.

TABLE I. Meteorological Observations made at Beeston Observatory.

1863, February 1st, to 1864, February 1st, each day ending at 10 A.M.

Daily Observations on the Direct Movement of the Wind.

Date.	1863.											1864.
	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.
	°	°	°	°	°	°	°	°	°	°	°	°
1	123	56	00	45	112	90	45	00	78	22	45	00
2	44	78	112	67	00	56	22	00	22	168	134	00
3	78	33	00	225	67	56	146	22	00	112	776	225
4	55	00	00	67	112	67	78	56	90	45	45	45
5	135	45	00	22	00	67	00	56	00	67	45	67
6	67	67	67	45	45	90	00	202	90	00	45	67
7	33	90	45	00	45	135	00	135	00	67	45	00
8	33	135	00	67	00	45	00	00	22	45	45	202
9	143	90	00	90	00	45	47	00	00	56	45	00
10	56	00	00	167	00	180	90	45	180	303	90	90
11	22	90	202	00	135	00	00	45	78	22	45	202
12	56	56	167	00	112	67	90	00	56	33	45	112
13	00	90	45	45	67	112	22	22	00	90	135	112
14	202	45	45	11	135	00	112	22	101	45	45	135
15	00	33	90	67	45	00	67	22	11	45	45	225
16	00	11	45	00	00	180	00	00	157	00	45	45
17	00	90	180	45	90	67	45	00	90	00	115	22
18	157	45	157	212	00	00	00	22	22	00	112	315
19	00	45	157	67	00	45	90	00	33	22	22	135
20	11	22	00	00	00	00	112	101	78	00	22	90
21	112	79	00	00	00	00	00	00	00	00	45	157
22	90	00	45	67	00	45	00	22	00	630	90	45
23	00	68	22	1080	90	67	00	45	00	00	22	112
24	45	45	00	427	00	45	22	00	00	22	00	247
25	33	00	67	267	67	00	00	00	00	00	00	112
26	33	00	00	45	45	112	90	90	00	22	22	00
27	22	45	22	00	33	00	90	00	00	00	112	00
28	00	22	67	00	00	00	112	100	90	00	416	45
29	...	157	67	00	00	00	90	00	45	00	236	292
30	...	67	112	00	157	135	67	90	100	00	78	202
31	...	00	...	157	...	45	315	...	101	...	00	22
Total ...	1550	1604	1714	3285	1357	1751	1772	1097	1444	1816	2967	3323

Table II. Meteorological Observations made at the Beeston Observatory.

Daily Observations on the Retrograde Movement of the Wind.

Date.	1863.											1864.
	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.
	°	°	°	°	°	°	°	°	°	°	°	°
1	179	112	00	00	00	180	22	202	33	33	00	00
2	67	78	00	45	00	22	45	67	45	157	90	00
3	22	45	45	22	22	00	34	45	22	157	765	180
4	90	22	00	67	22	45	67	00	00	00	45	90
5	101	22	00	00	45	00	00	56	22	22	45	67
6	66	45	00	90	45	00	00	146	202	00	45	202
7	33	22	112	202	00	00	00	112	22	00	45	67
8	00	112	00	00	45	00	22	45	90	67	45	90
9	157	90	00	22	00	45	45	22	00	22	45	270
10	90	00	00	00	157	00	00	00	90	00	45	90
11	45	00	180	67	315	00	00	45	67	11	45	112
12	00	56	00	45	470	157	45	00	90	00	45	67
13	00	135	45	45	270	67	00	22	22	202	45	135
14	00	00	45	56	101	135	00	22	33	00	67	247
15	22	112	90	22	56	00	00	00	22	45	45	112
16	00	214	45	00	79	22	00	22	79	00	45	45
17	00	101	00	45	112	180	22	45	90	22	25	22
18	67	67	22	00	225	45	00	22	67	45	147	247
19	00	67	00	45	00	45	90	00	22	00	22	202
20	157	67	00	00	45	00	22	78	00	00	112	112
21	00	22	00	00	112	00	00	22	00	00	00	112
22	00	11	00	90	45	360	45	45	00	270	00	45
23	00	90	00	1102	22	112	45	00	00	00	90	45
24	00	45	22	472	45	45	22	00	00	22	00	225
25	90	00	22	200	00	00	00	90	135	22	67	135
26	00	22	00	00	112	22	67	00	22	33	45	22
27	00	22	67	135	22	90	157	00	00	00	22	00
28	22	00	22	00	33	00	90	101	00	00	236	00
29	...	00	45	00	00	00	45	33	90	11	90	67
30	...	00	112	00	157	00	00	146	101	45	22	123
31	...	00	...	00	...	00	157	...	56	...	202	44
Total ...	1208	1579	874	2772	2557	1572	1042	1388	1422	1186	2542	3175

TABLE III. Meteorological Observations made at the Highfield House Observatory.

Daily Observations on the Direct or Retrograde Movement of the Wind.

(+ direct, − retrograde, = direct and retrograde equal, o motionless).

Date.		1863.											1864.
		February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.
1		−	−	o	+	+	−	+	−	+	−	+	o
2		−	=	+	+	o	+	−	−	−	+	+	o
3		+	−	−	+	+	+	+	−	−	−	+	+
4		−	−	o	=	+	+	+	+	+	+	=	−
5		+	+	o	+	−	+	o	=	−	+	=	=
6		+	+	+	−	=	+	o	+	−	o	=	−
7		=	+	−	−	+	+	o	+	−	+	=	−
8		+	+	o	+	−	+	−	−	−	−	=	+
9		−	=	o	+	o	=	+	−	o	+	=	−
10		−	o	o	+	−	+	+	+	+	+	+	=
11		−	+	+	−	−	o	o	=	+	+	=	+
12		+	−	+	−	−	−	+	o	−	+	=	+
13		o	−	=	=	−	+	+	=	−	−	+	−
14		+	+	=	−	+	−	+	=	+	+	−	−
15		−	−	=	+	−	o	+	+	−	=	=	+
16		o	−	=	o	−	+	o	−	+	o	=	=
17		o	−	+	=	−	−	+	−	=	−	+	=
18		+	−	+	+	−	−	o	=	−	−	−	+
19		o	−	+	+	o	=	=	o	+	+	=	−
20		−	−	o	o	−	o	+	−	+	o	−	−
21		+	+	o	o	−	o	o	−	o	o	+	+
22		+	−	+	−	−	−	−	−	o	+	+	=
23		o	−	+	−	+	−	−	+	o	o	−	+
24		+	=	−	−	−	=	=	o	o	=	o	+
25		−	o	+	+	+	o	o	−	−	−	−	−
26		+	−	o	+	−	+	+	+	−	−	−	−
27		+	+	−	−	+	−	−	o	o	o	+	o
28		−	+	+	o	−	o	+	−	+	o	+	+
29		...	+	+	o	o	o	+	−	−	−	+	+
30		...	+	=	o	=	+	+	−	−	−	+	+
31		...	o	...	+	...	+	+	...	+	...	−	−
Total	+	12	11	12	13	8	13	16	7	10	11	12	12
	−	10	14	4	9	16	8	5	14	14	10	7	11
	=	1	3	5	3	2	3	2	5	1	2	11	5
	o	5	3	9	6	4	7	8	4	6	7	1	3

LXII. *The Terrific Gale of December* 2, 1863. *Was it a direct Gale, or a Cyclonic (Circular) Storm?* By Lieut.-Col. HENRY AUSTEN.

I HAVE taken great pains to ascertain all the particulars I can, from French and English sources, regarding the great gale which scourged England and France last December, but cannot find any specific report of the *exact winds* that blew over France, or at Paris and Bordeaux, on the forenoon of December 2, 1863; the following 'Weather Reports,' however, of our own Board of Trade, as published daily, furnish me with certain data, leading me to conclusions which do not accord with those given by M. Leverrier in the 'Patrie,' that this storm was a *cyclone* coming *from* the N.W.

The Weather.—Meteorological Reports.

Monday, November 30, 1863, 8 A.M.

	B.	W.	F.	X.	Q.
	in.				
Nairn	30·09	S.	1	2	20
Aberdeen	30·19	S.E.	3	5	18
Leith	30·17	S.E.	2	2	16
Shields	30·21	S.W.	5	2	20
Scarboro'	30·22	S.	1	2	18
Greencastle	30·04	S.S.E.	4	2	12
Galway	29·95	E.S.E.	2	6	14
Valentia	29·86	S.	2	6	14
Queenstown	29·83	S.E.	6	5	12
Liverpool	30·17	E.S.E.	3	4	10
Holyhead	30·08	S.S.E.	2	3	14
Pembroke	30·05	S.E.	3	5	10
Penzance	30·01	S.E.	6	8	12
Brest	29·96	E.	5	3	8
L'Orient	29·96	E.N.E.	3	5	6
Rochefort	29·96	S.E.	5	4	8
Plymouth	30·16	N.E.	8	8	6
Weymouth	30·10	E.S.E.	4	6	8
Portsmouth	30·12	S.E.	3	6	8
London	30·18	E.S.E.	2	4	12
Dover	30·20	S.E.	3	4	8
Yarmouth	30·23	S.S.E.	4	6	10

Drum on north-east and west coasts, south cone on south and south-east coasts, Tuesday morning, December 1.

Explanation.—B. Barometer, corrected and reduced to 32° at half-tide level. W. Wind, direction of (*true*—two points *left* of magnetic). F. Force (1 to 12—estimated). X. Extreme force since last report. Q. Quarter whence *extreme* force (N.N.E. =2, to 32=N.).

The Weather.—Meteorological Reports (*continued*).

Tuesday, December 1, 1863, 8 A.M.

	B.	W.	F.	X.	Q.
	in.				
Nairn	29·56	S.W.	2	6	16
Aberdeen	29·68	S.E.	7	4	12
Leith	29·61	S.E.	4	5	12
Shields	29·81	S.	4	2	16
Scarboro'	29·84	S.	4	6	16
Greencastle	29·26	S.	9	10	14
Galway	29·24	S.S.W.	6	8	12
Queenstown	29·33	S.W.	7	6	12
Liverpool	29·69	E.S.E.	4	4	10
Holyhead	29·47	S.S.E.	7	7	14
Pembroke	29·59	S.S.E.	5	6	12
Penzance	29·66	S.W.	5	8	12
Brest	29·76	S.S.W.	9	3	10
L'Orient	29·61	S.	9	3	6
Rochefort	30·00	S.	4	3	12
Plymouth	29·71	S.S.E.	8	8	10
Weymouth	29·78	S.	5	4	10
Portsmouth	29·84	S.S.W.	5	5	10
London	29·87	S.S.E.	3	3	10
Dover	29·93	S.	6	3	8
Yarmouth	29·92	S.S.E.	4	5	14
Heligoland	30·18	S.E.	7	8	12

Wednesday, December 2, 1863, 8 A.M.

	B.	W.	F.	X.	Q.
	in.				
Nairn	29·22	S.S.W.	2	3	18
Aberdeen	29·22	S.S.E.	3	8	10
Leith	29·17	E.	1	4	12
Shields	29·15	S.S.E.	3	5	16
Scarboro'	29·17	S.	6	8	16
Greencastle	29·22	W.	2	9	28
Galway	29·31	W.S.W.	2	6	18
Queenstown	29·25	W.N.W.	7	8	20
Valentia	29·44	N.W.	4	10	16
Liverpool	29·04	E.S.E.	2	5	12
Holyhead	29·01	E.N.E.	4	6	18
Pembroke	28·97	N.W.	9	9	20
Penzance	29·24	N.W.	11	5	24
L'Orient	29·29	W.	10	6	20
Rochefort	29·57	W.	7	4	16
Plymouth	28·99	S.W.	10	9	18
Weymouth	28·98	W.	2	9	20
Portsmouth	28·99	S.W.	4	8	18
London	29·04	S.	6	9	18
Dover	29·07	S.	10	6	16
Yarmouth	29·26	S.E.	6	6	16
Heligoland	29·72	S.	7	8	16

The Weather.—Meteorological Reports (*continued*).

Thursday, December 3, 1863, 8 A.M.

	B.	W.	F.	X.	Q.
	in.				
Nairn	28·97	S.S.W.	2	4	18
Aberdeen	28·95	N.W.	2	4	28
Shields	28·81	S.S.W.	4	6	14
Scarboro'	28·77	S.S.E.	9	10	28
Holyhead	29·02	W.N.W.	9	10	24
Pembroke	29·27	N.W.	9	9	24
Penzance	29·49	N.W.	7	8	24
Brest	29·49	S.	9	8	26
L'Orient	29·41	S.W.	9	9	24
Plymouth	29·34	W.	12	12	24
Weymouth	29·25	N.W.	10	11	28
Portsmouth	29·14	W.N.W.	11	12	22
London	28·98	W.	10	11	24
Dover	29·08	W.	10	10	24
Yarmouth	28·96	S.S.W.	10	10	28

A slight study of the correctly drawn Chart (Plate XXV.) may satisfy anemologists that my reasoning thereon is correct, and my deduction a valid one.

The *black* arrows give the direction of the winds that blew at each place at 8 A.M., December 3, 1863 (as given in the 'Weather Reports' of the Board of Trade);

The *red*, those on December 2; and

The *green*, those on December 1.

As M. Leverrier considers that the *cyclone* came *from the N.W.*, I have here treated that assertion hypothetically, both in the form of a *circular* gale and also as a *direct* gale, moving downwards, over France, from that quarter of the compass; and in neither case can I discover that his inference is well formed, nor can I verify the conclusions to which he has arrived, consistently with the facts stated (meagre though they be), nor with the *cyclonic laws* now recognized by all meteorologists. For, first, presuming it was a cyclone, the sweep of a cyclone, indicated here by the *curved green arrows upwards* (in the semicircle), would have given throughout the area of that semicircle the *several* winds indicated in the quadrants A C of the *Index Cyclone* diagram. Moreover, the sweep of such a cyclone, the vortex of which is at the supposed spot, marked by the *red patch*, to embrace Bordeaux and Paris *simultaneously*, must have affected Limoges also in its circular whirl, which the 'Patrie' said *it did not*, at 10 A.M., December 2, when Paris and Bordeaux felt the gale synchronously.

Again, had the gale been a *direct* N.W. one, it could not have affected Bordeaux and Paris at the same time, as indicated by the *green* line between the two terminal *stars*; whereas, according to my inference, from the winds blowing, as shown by the diagram, to the north-west of France, generally in the *direction* and with the *force* as marked by the *red* arrows respectively, the said gale affected France on December 2, generally as a *direct* W.N.W. storm, the course of which I have marked with *red* parallel lines on the diagram; and on such a supposition alone can I reconcile all the data at my command. Furthermore I would observe that the *shift* of wind at Marseilles, at 9 A.M., December 2, *from the S.W.*, proves that it could not be a veritable cyclone, proceeding *from* the N.W., since the N.E. would have the wind in *such a case*, according to all cyclonic laws; for the test-winds of the *axial* line of progression in all such phenomena are *the exact opposites*, each blowing for exactly the same period of time continuously. I hope I have made myself intelligible in this matter.

In venturing, however, as I thus do, to demur to the conclusions arrived at by two such eminent *savants* as M. Leverrier and M. Marié Davy, it will be necessary to give a summary of the several facts recorded in the French papers respecting that terrific gale, in order fairly to estimate the true character of that phenomenon. In the 'Patrie' newspaper they were thus generalized:—"The ports from Dunkirk to Nantes were warned by telegraph, on December 1st, that a tempest, *arriving from the S.W.* [mark this, the S.W.], was about to sweep over France; that on the 2nd of December *this* prediction *was fulfilled* [by a cyclone *from* the N.W.?], and that it raged over the north and west of France, the gale being felt simultaneously at Paris and Bordeaux at 10 A.M., but *not* at Limoges or Bayonne till later, having burst out at Cherbourg the *previous* night, and Hâvre *first* feeling the gale at *noon* of 2nd December; that the effects of the tempest were especially felt at Brest, Cherbourg, Nantes, Lille, Paris, Rouen, Hâvre, and Toulon; and, lastly, that a strong three hours S.W. wind at Marseilles was *succeeded* at 9 P.M., *that day*, by a gale from the N.W." As these journals give no *specific* winds, we are left to conjecture from *what* points of the compass they severally blew, in the progress of this tempest across France. Now, as the *direction* of the storm is stated to have been *from* the N.W., it must have been either a cyclonic or a straight gale, *from* that point of the compass. I consider that it was neither; for had it been a *cyclone*, the sweep of its radius-vector (*vide* Skeleton

Map) must have embraced Limoges when its upward whirl affected Paris and Bordeaux; whilst, if it had been a direct gale *from* that quarter, the front of that storm, as marked on the map by the *green* line drawn at right angles to the course of the *imaginary* cyclone (from near Guernsey to Marseilles), could not have been experienced synchronously at Paris and Bordeaux. The inference that I have drawn, therefore, from these geometrically negative proofs of neither of these deductions being legitimate is corroborated by the direction and force of the winds that were blowing at 8 A.M. on December 2 throughout England (as marked on the Map by my local wind-arrows), all of which are greatly at variance with the inference drawn by these eminent French *savants*. And the simple fact, announced by the papers, that the shift of the storm was suddenly felt at Marseilles from S.W. to N.W. will satisfy any one conversant with cyclonic action, that such a shift of wind was inconsistent with the rotatory action of a cyclone progressing from N.W. to S.E., and the resulting surface-winds thereof, hauling as they *must do* from the S.W., *by the W.*, to N.W. throughout the area traversed by the *lower* semicircle, or that under the long line on the Map, between Guernsey and Marseilles, and shifting contrariwise over the upper semicircular area, that is from S.W. to N.W. by the E.—and in each case in regular succession, and with a force of wind *increasing* in intensity according as the advancing cyclone brought the country scourged thereby within the influence of the W. and E. winds respectively; whilst over the vortical area itself, and throughout the whole course of such an assumed N.W. cyclone's progress, but *two* winds would prevail from first to last, viz. a S.W. and N.E. one in succession, and each lasting exactly for the same period, or as long as the vortex took to travel the length of the radius of the circle. All these facts considered, I feel fully justified in pronouncing that MM. Leverrier and Marié Davy were in error in designating the tempest of the 2nd of December, 1863, "as a cyclone of enormous dimensions *from the N.W.*"; whilst, on the other hand, I think my parallels of the W.N.W. gale (as indicated on the Map), from such a supposition satisfying all the conditions requisite for the storm-data above enumerated, confirm the conclusions at which I have arrived.

In conclusion, I may state that the Kew Observatory wind-tables for December last show the following shifts of wind, the record thereof being taken *daily* at 9 A.M., 2 P.M., and 5 P.M., November 30, 1863, E., N.N.E., N.N.E.; December 1, S.S.E.,

S., S. by W.; December 2, S., W.N.W., W. by N.; December 3, W.S.W., W. by S.,—the aggregate of the anemometer register for each twenty-four hours being for these days respectively 305, 362, 479, 748 miles per hour. Whilst the above records prove, therefore, that no such N.W. cyclone passed over London, they also evidence the fact that England experienced a heavier wind by far on the 3rd of December than on the 2nd of December, when France felt its terrific tempest; and yet from the fact of London being nearly due N.W. of Paris, a cyclone, travelling across *both* countries in succession ought, *de règle*, to have been *first* felt at Kew.

Table of the Maxima and Minima Air-pressure, and Temperature and Wind-force, within the area given on Pl. XXV., for 4 days; extracted from the Board of Trade Returns as published daily.

Date.	Places.	Maximum Barometer.	Minimum Barometer.	Maximum Temp.	Minimum Temp.	Direction of Wind.	Wind-force.
1863.		in.	in.	°	°		
Nov. 30	Yarmouth	30·23	......	......	......	S.S.E.	4
	Queenstown ...	......	29·83	50	......	S.E.	6
	London	......	......	......	34	E.S.E.	2
Dec. 1	Rochefort	30·00	......	......	......	S.	4
	Queenstown ...	......	29·33	......	......	S.W.	7
	L'Orient.........	......	......	52	......	S.	9
	Liverpool	......	......	......	41	E.S.E.	4
Dec. 2	Rochefort	29·57	......	......	......	W.	7
	Pembroke	......	28·97	......	......	N.W.	9
	Dover............	......	......	51	......	S.	10
	Rochefort	......	......	......	36	W.	7
Dec. 3	Brest	29·49	......	......	......	S.	9
	Scarboro'	......	28·77	......	......	S.S.E.	9
	L'Orient.........	......	......	55	......	S.W.	9
	Holyhead	......	......	......	43	W.N.W.	9

N.B. All these barometer-readings are reduced to half-tide level, and to 32° of temperature.

Total fall of barometer in above 4 days, 0·89 in.

Note.—This skeleton-chart of Western Europe may be utilized, and rendered most interesting too, hereafter, to any reader of the daily weather reports, by his simply tracing thereon, for two or three days consecutively, the shifts of wind over the area reported on, by simply laying pins of different lengths, like wind-vanes, to windward of each place, and leaving them on the Map, black pins being used to designate all winds *beyond* 8 force.—H. E. A.

BOOKS AND NOTICES.

XXII. *A Treatise on Meteorological Instruments, explanatory of their Scientific Principles, Method of Construction, and Practical Utility.* By NEGRETTI and ZAMBRA, Meteorological Instrument Makers to the Queen, the Royal Observatory, Greenwich, the British Meteorological Society, the British and Foreign Governments, &c. &c. Royal 8vo, pp. 150. Ninety-eight woodcuts. January 1, 1864.

THE Preface describes the volume as "giving a plain description of the various instruments now in use, ... condensing such information as is generally required regarding the instruments used in meteorology, ... every meteorological instrument now in use being fully described, with adequate directions for using." The authors include notices of the less scientific apparatus "which, though of no great practical importance, are still deserving of notice from their being either novel or ingenious, or which, without being strictly scientific, are in great demand as simple weather-glasses and articles of trade."

The subjects, discussed or described in sixteen chapters, are 158 in number. The chapters in order are:—Instruments for ascertaining the Atmospheric Pressure,—Siphon-tube Barometers,—Barographs, or Self-registering Barometers,—Mountain Barometers,—Secondary Barometers,—Instruments for ascertaining temperature,—Self-registering Thermometers,—Radiation-Thermometers,—Deep-sea Thermometers,—Boiling-point Thermometers,—Instruments for ascertaining the Humidity of the Air,—Instruments used for Measuring the Rain-fall,—Apparatus employed for Registering the Direction, Pressure, and Velocity of the Wind,—Instruments for investigating Atmospheric Electricity,—Ozone and its Indicators,—Miscellaneous Instruments.

Various Tables for correcting and reducing observations, and for other useful purposes, are given.

The following passages are extracted from the volume;—

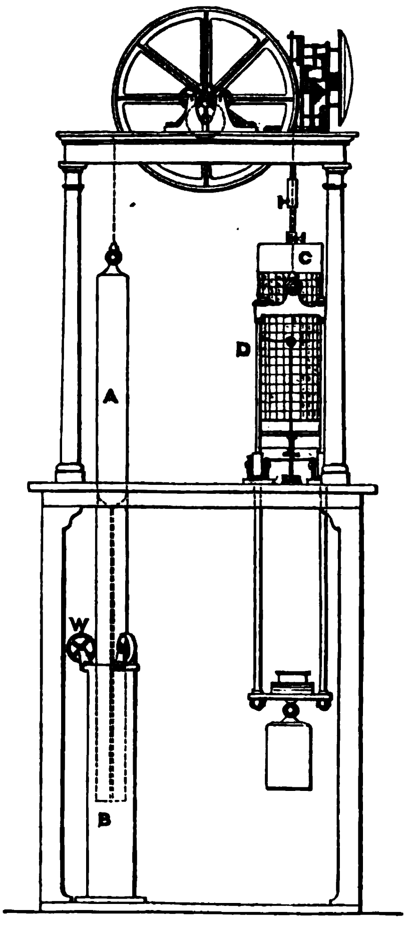
"SELF-COMPENSATING STANDARD BAROMETER.—This barometer has been suggested to Messrs. Negretti and Zambra by Wentworth Erk, Esq. It consists of a regular barometer; but attached to the vernier is a double rack worked with one pinion, so that in setting or adjusting the vernier in one position, the second rack moves in directly the opposite direction, carrying along with it a plug or plunger the exact size of the internal diameter of the tube dipping in the cistern; so that, whatever the displacement that has taken place in the cistern owing to the rise or fall of the mercury, it is exactly compensated by the plug being more or less immersed in the mercury, so that no capacity-correction is required.

"A barometer on this principle is, however, no novelty; for, at the Royal Society's room, a very old instrument may be seen reading somewhat after the same manner.

"KING'S SELF-REGISTERING BAROMETER.—Mr. Alfred King, Engineer of the Liverpool Gas-light Company, designed, so long

ago as 1854, a barometer to register, by a continuous pencil-tracing, the variations in the weight of the atmosphere; and a highly satisfactory self-recording barometer on his principle, and constructed under his immediate superintendence, has quite recently been erected at the Liverpool Observatory. Fig. 9 is the front elevation of this instrument. A, the barometer-tube, is 3 inches in internal diameter, and it floats freely (not being fixed as usual) in the fixed cistern, B, guided by friction-wheels, W. The top end of the tube is fastened to a peculiar chain, which passes over a grooved wheel turning on finely adjusted friction-rollers. The other end of the chain supports the frame, D, which carries the tracing-pencil. The frame is suitably weighted and guided, and faces the cylinder, C, around which the tracing-paper is wrapped, and which rotates once in twenty-four hours by the movement of a clock. Mr. Hartnup, Director of the Liverpool Observatory, in his Annual Report, 1863, says :—'For 1 inch change in the mercurial column the pencil is moved through 5 inches; so that the horizontal lines on the tracing, which are $\frac{1}{2}$ an inch apart, represent $\frac{1}{10}$th of an inch change in the barometer. The vertical lines are hour-lines; and being nearly $\frac{3}{4}$ of an inch apart, it will be seen that the smallest appreciable change in the barometer, and the time of its occurrence, are recorded.'

Fig. 9.



"It has been remarked by persons in the habit of reading barometers with large tubes, that, in squally weather, sudden and frequent oscillations of the mercurial column are sometimes seen. Now, to register these small oscillations must be a very delicate test of the sensitiveness of a self-registering barometer, as the time occupied by the rise and fall of the mercury in the tube in some cases does not exceed one minute. Mr. Hartnup affirms

that the tracing of this instrument exhibits such oscillations whenever the wind blows strong and in squalls.

"As the barometer in this instrument is precisely similar to the 'Long-Range Barometer' invented by Mr. McNeild [the description of which follows, p. 175], it may be desirable to quote the following from Mr. Hartnup's Report:—'Mr. King constructed a small model instrument to illustrate the principle. This instrument was entrusted to my care for examination, and it was exhibited to the scientific gentlemen who visited the Observatory in 1854, during the Meeting of the British Association for the Advancement of Science.'

"Short-tube Barometer.—This is simply a tube shorter, as may be required, than that necessary to show the atmospheric pressure at the sea-level. It is convenient for balloon purposes, and for use at mountain stations, being of course a special construction.

"McNeild's Long-range Barometer.—A barometer designed by a gentleman named McNeild is on a directly opposite principle to Howson's*. The tube is made to float on the mercury in the cistern. It is filled with mercury, inverted in the usual manner, then allowed to float, being held vertically by glass friction-points or guides. By this contrivance, the ordinary range of the barometer is greatly increased. One inch rise or fall in the standard barometer may be represented by 4 or 5 inches in this instrument, so that it shows small variations in atmospheric pressure very distinctly. As the mercury falls in the tube with a decrease of pressure, the surface of the mercury in the cistern rises, and the floating tube rises also, which causes an additional descent in the column, as shown by fixed graduations on the tube. With an increase of pressure, some mercury will leave the cistern and rise in the tube, while the tube itself will fall, and so cause an additional ascent of mercury. This barometer is identical in principle with King's barograph [just described, p. 174].

"The construction of Howson's and McNeild's barometers has been assigned to Messrs. Negretti and Zambra. These instruments are usually made for domestic purposes with a scale of from three to five, and for public use from five to eight times the scale of the ordinary standard. Their sensitiveness is consequently increased in an equal proportion, and they have the additional advantage of not being affected by differences of level in the cistern. However, these novelties have not been sufficiently tried to determine their practical value for strictly scientific purposes; but as weather-glasses, for showing minute changes, they are superior to the common barometer.

"Measurement of Heights by the Aneroid.—For measuring heights not exceeding many hundred feet above the sea-level by means of the aneroid, the following simple method will suffice:—

"Divide the difference between the aneroid readings at the lower and upper stations by ·0011; the quotient will give the approximate height in feet. Thus, supposing the aneroid to read at the

* *Vide* Proceed. Meteor. Soc. vol. i. p. 81.

Lower station.............................	30·385 inches.
Upper station.............................	30·025 „
Difference	·360

$$\text{Divided, gives } \frac{\cdot 360}{\cdot 0011} = 327 \text{ feet.}$$

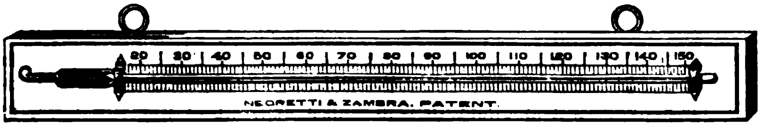
"THERMOMETERS OF EXTREME SENSITIVENESS.—Messrs. Negretti and Zambra have now introduced a new form of thermometer, which combines sensitiveness and quickness of action together with a good visible column. The bulb of this thermometer is of the grid-iron form. Care has been taken in constructing the bulb so that the objections attending spirals and other forms have been overcome; for whilst the reservoir or bulb is made of glass so thin that it is only by a spirit-lamp and not a glass-blower's blowpipe that it can be formed, yet it is still so rigid (owing to its peculiar configuration) that no variations in its indications can be detected, whether it be held in a horizontal, vertical, or oblique position, nor will any error be detected if it be stood on its own bulb. They have made thermometers with bulbs or reservoirs formed of about 9 inches of excessively thin cylindrical glass whose outer diameter is not more than $\frac{1}{20}$th of an inch; so that, owing to the large surface presented, the indications are positively instantaneous. This form of thermometer was constructed expressly to meet the requirements of scientific balloon ascents, to enable thermometrical readings to be taken at the precise elevation. It was contemplated to procure a metallic thermometer; but on the production of this perfect instrument the idea was abandoned.

"IMPORTANCE OF SELF-REGISTERING THERMOMETERS.—But we would observe that the actual mean temperature of any place has not such an important influence upon life, either animal or vegetable, as the abruptness and magnitude of the variations of temperature. Climate, therefore, should be estimated more by the range of the thermometer than by the average of its indications. The Registrar General's returns prove that with a wide range of the thermometer the mortality greatly increases; and it is now becoming apparent to meteorologists that the daily range of the thermometer marks the effects of temperature on the health of men, and the success of crops, better than any other meteorological fact of which we take cognizance. Now that self-registering thermometers are constructed with mercury, the most appropriate of all thermometric substances, not only for maxima, but likewise for minima temperatures, the determination of the diurnal range of temperature is rendered more certain, and observations at different places are more strictly comparable.

"NEGRETTI AND ZAMBRA'S SECOND PATENT MERCURIAL MINIMUM THERMOMETER.—In this thermometer a principle is used that has been long known to scientific men, viz. the affinity of mercury for platinum. If mercury be placed in contact with platinum under ordinary circumstances, no effect will take place; but if the mercury is once made to attack the platinum, the amalgamation is permanent and the contact perfect, so much so that the principle was made use of in constructing standard barometers. A ring of

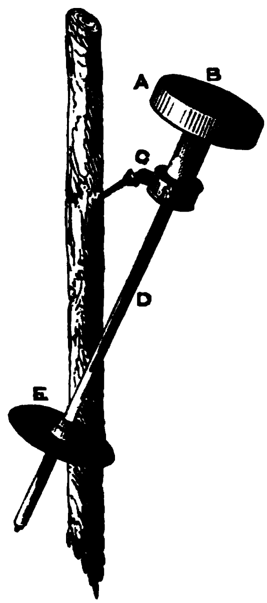
platinum was fused round the end of the tube dipping into the mercury; and the contact between the platinum and mercury became so perfect that air could not creep down the tube and up the bore as in ordinary barometer-tubes. This principle of adhesion or affinity of mercury for platinum has been brought into play for the purpose of arresting the mercury after it has reached the minimum temperature in a thermometer. This thermometer is made as follows:—Behind the bulb is placed a supplementary chamber. In the space or neck between the bulb of the thermometer and the chamber is placed a small piece of platinum; this may be of any shape or size; but the smaller the better. This is not to fit in the neck; it must, on the contrary, be rather loose: it may be fastened in position or not. The instrument is represented by fig. 10.

Fig. 10.



"POUILLET'S PYRHELIOMETER.—This instrument is composed of a shallow cylinder of steel (A, fig. 11), which is filled with mercury. Into the cylinder a thermometer, D, is introduced, the stem of which is protected by a piece of brass tubing. We thus obtain the temperature of the mercury. The flat end of the cylinder is to be turned towards the sun, and the surface, B, thus presented is coated with lamp-black. There is a collar and screw, C, by means of which the instrument may be attached to a stake driven into the ground, or into the snow, if the observations are made at considerable heights. It is necessary that the surface which receives the sun's rays should be perpendicular to the rays; and this is secured by appending to the brass tube which shields the stem of the thermometer, a disk, E, of precisely the same diameter as the steel cylinder. When the shadow of the cylinder accurately covers the disk, we are sure that the rays fall as perpendiculars on the upturned surface of the cylinder.

Fig. 11.



"The observations are made in the following manner:—'First, the instrument is permitted, not to receive the sun's rays, but to radiate its own heat for five minutes against an unclouded

part of the firmament; the decrease of the temperature of the mercury consequent on this radiation is then noted. Next, the instrument is turned towards the sun, so that the solar rays fall perpendicularly upon it, for five minutes; the augmentation of heat is now noted. Finally, the instrument is turned again towards the firmament, away from the sun, and allowed to radiate for another five minutes, the sinking of the thermometer being noted as before. In order to obtain the whole heating-power of the sun, we must add to his observed heating-power the quantity lost during the time of exposure; and this quantity is the mean of the first and last observations. Supposing the letter R to represent the augmentation of temperature by five minutes' exposure to the sun, and that t and t' represent the reductions of temperature observed before and after, then the whole force of the sun, which we may call T, would be thus expressed:—

$$T=R+\tfrac{1}{2}(t+t').$$

"'The surface on which the sun's rays here fall is known; the quantity of mercury within the cylinder is also known; hence we can express the effect of the sun's heat upon a given area, by stating that it is competent, in five minutes, to raise so much mercury so many degrees in temperature.'—Dr. TYNDALL'S '*Heat Considered as a Mode of Motion.*'

"CAUSES OF DEW.—'The aqueous vapour of our atmosphere is a powerful radiant; but it is diffused through air which usually exceeds its own mass more than one hundred times. Not only, then, its own heat, but the heat of the large quantity of air which surrounds it must be discharged by the vapour, before it can sink to its point of condensation. The retardation of chilling due to this cause enables good solid radiators, at the earth's surface, to outstrip the vapour in their speed of refrigeration; and hence, upon these bodies, aqueous vapour may be condensed to liquid, or even congealed to hoar-frost, while at a few feet above the surface it still maintains its gaseous state'*. The amount of moisture so deposited will vary with different atmospheric conditions. If the sky be decidedly cloudy or misty, the heat radiated from the earth will be partly restored by counter-radiation from the visible vapour; the cooling of the earth's surface will therefore take place slowly, and little dew will be deposited. On the other hand, if the air contain transparent vapour, and the sky appear clear, the counter-radiation will be less, the earth will cool rapidly, and the deposit of dew will be copious, provided the night be comparatively calm; for, when the wind blows, the circulating air supplies heat to the radiating substances, and prevents any considerable chilling.

"NEW FORM OF RAIN-GAUGE.—Since the foregoing pages were in type, a modification of Howard's rain-gauge has been arranged by Mr. Symons, which is compact in design, convenient in use, and low in price. It combines the advantages of most gauges, having solidity and facility of measurement. The bottle is placed in a

* Tyndall's 'Heat Considered as a Mode of Motion.'

tin case, to the bottom of which are attached stout spikes, which, when forced into the earth, prevent its being upset either by wind or accident. The bottle being transparent, and slits made in the case, the fall of rain is seen at a glance, or with a race-glass, from a window. The funnel, being attached to the cover of the case, is thereby kept strictly horizontal; and the depth of rain can be accurately measured by lifting the bottle from its case and emptying it into a graduated glass jar.

"The funnel of this gauge is a very deep cone, to prevent the rain-drops out-splashing. When properly placed, the receiving surface will be 12 inches above the ground, which experience has shown to be the most advantageous height.

"SELF-REGISTERING LIND'S ANEMOMETER.—A Lind's wind-gauge, designed to register the maximum pressure, was exhibited at the International Exhibition, 1862, by Mr. E. G. Wood. The bend of the siphon is contracted to obtain steadiness. On the leeward limb a hole is drilled corresponding in size with the contracted portion of the tube. The edge of the hole corresponds with the zero of the scale. On the pressure of the wind increasing, as much of the water as would have risen above the aperture flows away; and therefore the quantity left indicates the greatest pressure of the wind since the last setting of the instrument, which is done by filling it with water up to the zero-point.

"THOMSON'S ELECTROMETER.—Professor W. Thomson, of Glasgow, has devised an atmospheric electrometer, which is likely to become eminently successful in the hands of skilful observers. It is mainly a torsion-balance combined with a Leyden jar. The index is an aluminium needle strung on a fine platinum wire passing through its centre of gravity, and stretched firmly between two points. The needle and wire are carefully insulated from the greater part of the instrument, but are in metallic communication with two small plates fixed beside the two ends of the needle, and termed the repelling plates. A second pair of larger plates face the repelling plates, on the opposite side of the needle, but considerably further from it. These plates are in connexion with the inner coating of a Leyden jar, and are termed the attracting plates. The whole instrument is enclosed in a metal cage, to protect the glass Leyden jar and the delicate needle.

"The Leyden jar should be charged when the instrument is used. Its effect is twofold: it increases greatly the sensibility of the instrument, and enables the observer to distinguish between positive and negative electrification.

"The air inside the jar is kept dry by pumice-stone slightly moistened with sulphuric acid, by which means very perfect insulation is maintained.

"Electrodes, or terminals, are brought outside the instrument, by which the Leyden jar can be charged, and the needle-system connected with the body the electric state of which is to be tested.

"For the purpose of testing the electric state of the atmosphere, the instrument is provided with a conductor and support for a

burning match, or, preferably, with an arrangement termed a water-dropping collector, by either of which means the electricity of the air is conveyed to the needle-system.

"The needle abuts upon the repelling plates when not influenced by electricity, in which position it is at zero. It can always be brought back to zero by a torsion-head, turning one end of the platinum wire, but insulated from it, and provided with a graduated circle, so that the magnitude of the arc that the torsion-head is moved through to bring the needle to zero measures the force tending to deflect it.

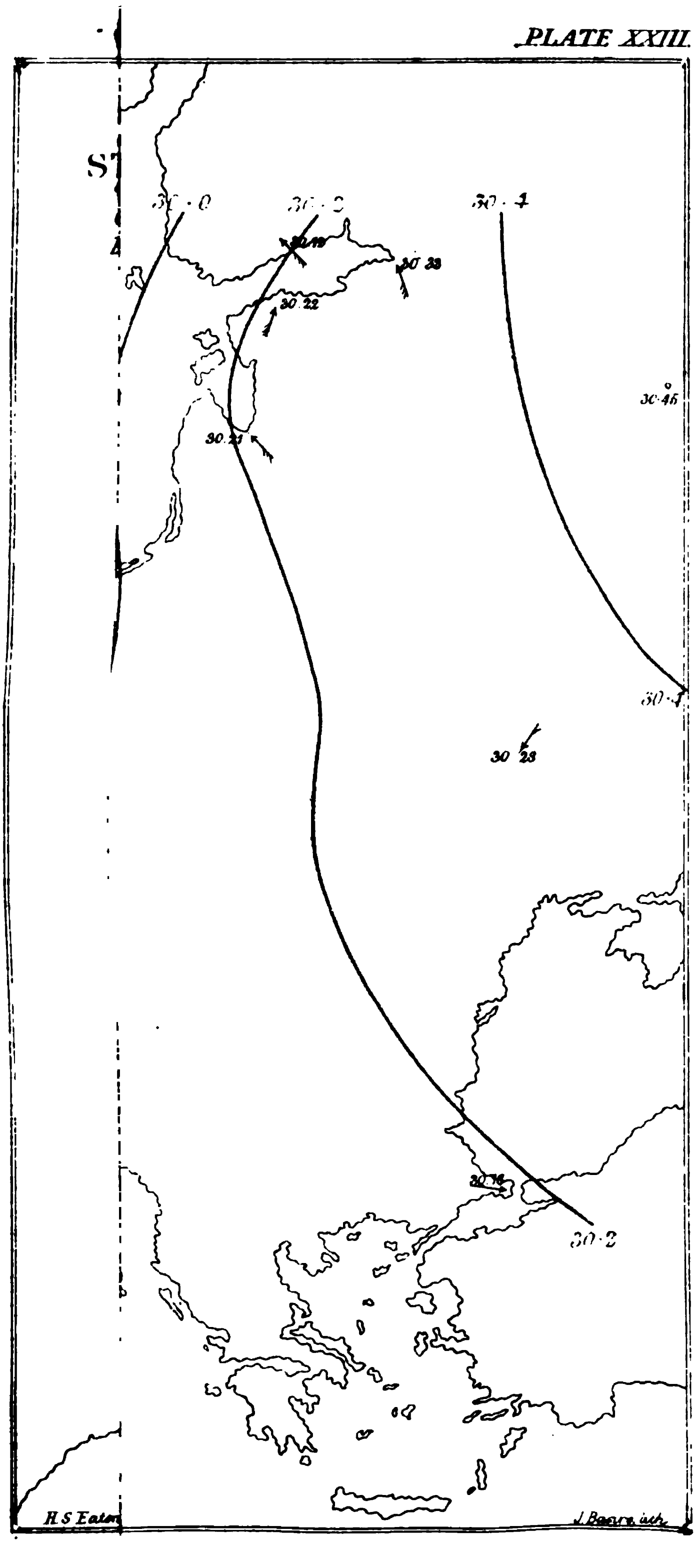
"The action of the instrument is as follows:—The Leyden-jar is to be highly charged, say negatively; and the repelling plates are to be connected with the earth. The needle will then be deflected against a stop, under the combined influence of attraction from the Leyden jar, or attracting plates, and repulsion from the repelling plates due to the positive charge induced on the needle and its plates by the Leyden-jar plates. The platinum wire must then be turned round by the torsion-head so as to bring back the needle to zero; and the number of degrees of torsion required will measure the force with which the needle is attracted. Next, let the needle-plates be disconnected from the earth, and connected with the insulated body the electric state of which is to be tested. In testing the atmosphere, the conductor and lighted match, or water-dropping apparatus must be applied. If the electricity of the body be positive, it will augment the positive charge in the needle-plates, induced by the Leyden-jar plates; and consequently the needle will be more deflected than by the action of the jar alone. If the electricity of the body be negative, it will tend to neutralize the positive charge; and the needle will be less deflected. Hence the kind of electricity present in the air becomes at once apparent, without the necessity of an experimental test. The platinum wire must then be turned till the needle is brought to zero, and the number of degrees observed, which is a measure of the intensity of the electrification.

"Any loss of charge from the Leyden jar which may from time to time occur, reducing the sensibility inconveniently, may be made good by additions from a small electrophorus which accompanies the instrument*.

"The instrument may be made self-recording by the aid of clock-work and photography. To effect this, a clock gives motion to a cylinder, upon which photographic paper is mounted. The needle of the electrometer is made to carry a small reflector; and rays from a properly adjusted source of light are thrown by the reflector, through a small opening, upon the photographic paper. It is evident that, as the cylinder revolves, a trace will be left upon the paper, showing the magnitude of, and variations in, the deflection of the needle."

* This description is modified from that in 'Report of the Jurors for Class XIII., International Exhibition, 1862.'

PLATE XXIII.



PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

VOL. II. 1864, APRIL 20. [No. 13.

R. DUNDAS THOMSON, Esq., M.D., F.R.S. L. & E.,
President, in the Chair.

Charles Coppock, Esq., 31 Cornhill, E.C.;
George Dines, Esq., Grosvenor Road, Pimlico;
Henry Dodgson, Esq., M.D., Cockermouth, Cumberland;
Samuel Gurney, Esq., M.P., 25 Princes Gate, Hyde Park, S.W., and Carshalton, Surrey, S;
Walter E. Pain, Esq., Cambridge;
Augustus Smith, Esq., M.P., 1 Eaton Place;
were balloted for and duly elected Members of the Society.

The names of Seven Candidates for admission into the Society were read.

The following gentlemen, who had been duly elected Members, subscribed the Form No. 2, and were admitted into the Society:—

	Elected
John W. Eccles, Esq.	1864, February 17.
F. Gaster, Esq.	1864, February 17.
Rev. F. Silver	1862, March 19.
Charles D. Turton, Esq. (by proxy)	1863, November 18.

LXIII. *On the Meteorology of England for the Years* 1858 *to* 1862, *and the Combination of the Results with those of the Years* 1855, 1856, *and* 1857. By JAMES GLAISHER, Esq., F.R.S., Secretary.

THE daily readings of the several meteorological instruments have been received by me, for the most part, at the end of every month; these have been examined by comparing the several readings on the same day, at places situated near to each other, and thus eliminating erroneous readings. After this examination, the mean for the month has either been taken or, if previously taken, examined, the hygrometrical values calculated, and quarterly values of the several elements deduced; and the results have been published at the end of every three months.

In the Eighth Annual Report of this Society (p. 116) will be found a paper of mine on the "Meteorology of the Years 1855, 1856, and 1857." The paper I have the honour of bringing under your notice this evening is a continuation of that paper, brought up to the end of the year 1862.

In this further reduction of the observations, the first process was to copy out the corrected monthly means of all elements for every station in each year; so that all the results in one year from each station were collected together, and could be seen at a glance.

1858.

On discussing the monthly results thus collected for the year 1858, it was found that the mean monthly reading of the barometer alternately increased and decreased during the year at all stations.

The maximum reading occurred in January at all parts of the country: the minimum, in November and December in the southern and northern parts of the country respectively; in April and May at places situated near London, and in the midland counties.

The temperature of the air was lowest in January, February, and March at southern stations; in November at places round London; and in March and November at places situated towards the centre, and in the northern parts of the country.

Near London, the mean temperature of the air for the

Spring quarter (March to May) was the same as the average;

Summer quarter (June to August), $2\frac{1}{2}°$ above the average;

Autumn quarter (September to November), $0°.9$ above the average;

Winter quarter (December to February), 0°·4 above the average;

And of the whole year, 1°·8 above the average.

This year is also characterized by some violent thunder-storms in the month of June.

Mr. Eaton, of Little Bridy, reports a storm of unparalleled violence having occurred on the 10th in the N.W. parts of Dorsetshire. The lightning and thunder, he says, were more terrific than any that had occurred since July 1808. The Rev. John Slatter, of Rose Hill, writes, June 16th, "A most furious storm at this place at 9^h 45^m A.M. from the W. and N.W. A violent hurricane preceded it, and the rain was slow to come, and not remarkable (about half an inch); but the lightning flashed fourteen times in about thirty seconds, and the thunder was incessant. I never witnessed," he remarks, "such elemental fury. No damage was done here beyond striking a fine elm tree, but elsewhere it was very mischievous."

The fall of rain was nearly 2 inches below the average.

1859.

The mean reading of the barometer, at southern stations, alternately increased and decreased to May; then there was a gradual increase to July, followed by a gradual decrease to October, then an increase and decrease to December. In the central parts of the country there was a gradual decrease to April, then an alternate increase and decrease to the end of the year; in the northern parts there was an alternate decrease and increase to July, then a gradual decrease to November, and increase in December. The maximum and minimum readings occurred in January and October respectively at all parts of the country.

The maximum temperature of the air occurred in July, and the minimum in October, all over the country.

This year is characterized by the very warm weather which occurred during the summer quarter: the mean temperature near London of the three months June to August was 64°·3; and this is the highest temperature which has occurred in this quarter since 1771; it was very nearly approached in the year 1818, viz. 64°·2; in the year 1846 it was the same as in 1859, viz. 64°·3. This was followed by a period of very severe weather in the month of December, viz. from the 14th to the 19th: at many places the

temperature descended as low as 10°; but at Lampeter the minimum temperature was returned as −2°.

Near London, the mean temperature of the

Spring quarter was 2°·3 above the average;
Summer quarter, 4°·3 above the average;
Autumn quarter, 0°·7 below the average;
Winter quarter, 0°·4 below the average.

The fall of rain during the year was half an inch above the average.

1860.

The meteorology of this year was discussed by me, and the results read to the Society, on November 21st, 1860. They have since been published in the Report for the year 1861.

The mean reading of the barometer alternately increased and decreased during the year.

The maximum reading occurred in February all over the country; and the minimum in December in the southern and central parts of England, and in January in the northern parts.

The temperature decreased from January to February, then increased to July, and decreased to the end of the year. The maximum occurred in July. The minimum occurred in February at southern stations, and in December at others.

On December the 14th of this year a cold period set in, which continued till the middle of January 1861. Papers were read on the extraordinary cold weather which occurred at this period of the year, both in Europe and in America; the very cold period did not, however, reach America until the beginning of February.

The mean temperature of the air near London, in the

Spring quarter was 0°·5 below the average;
Summer quarter, 3°·4 below the average;
Autumn quarter, 1°·1 below the average;
Winter quarter, 0°·5 below the average.

The fall of rain in this year exceeded the average by a considerable amount, viz. nearly 7 inches.

1861.

The mean reading of the barometer decreased to February at southern stations, and to March at others; then increased to April, decreased to July, and alternately increased and decreased during the remainder of the year. The maximum occurred in April at

northern stations, and in January at others. The minimum occurred in November all over the country.

The cold weather which occurred during the first half of January in this year has already been discussed, and the results, embodied in a short paper, laid before the Society. Carrying out the discussion for the remainder of the year, it was found that the temperature gradually increased to the month of August, in which month the maximum temperature of the air occurred; a gradual decline then took place, but the temperature did not descend so low as it had done in the previous January.

The mean temperature of the air in the neighbourhood of London, in the

Spring quarter, was 0°·3 above the average;
Summer quarter, 1°·0 above the average;
Autumn quarter, 1°·5 above the average;
Winter quarter, 2°·6 above the average.

The fall of rain for the year was 5 inches below the average of the preceding forty-six years.

1862.

The mean reading of the barometer in this year alternately increased and decreased to May; then a gradual increase to July, a gradual decrease to November, and an increase in December.

The maximum mean reading occurred in December at extreme southern stations, and February at all other stations. The minimum occurred in March all over the country.

The temperature increased till it reached its maximum in the month of August, and then gradually declined to November, with a slight increase in December.

The minimum temperature took place in the month of January at nearly all stations.

The mean temperature of the air in the neighbourhood of London, in the

Spring quarter, was 2°·5 above the average;
Summer quarter, 0°·4 below the average;
Autumn quarter, 0°·4 above the average;
Winter quarter, 4°·7 above the average.

The fall of rain for the year was $1\frac{1}{2}$ inch in excess of the average.

The means for the year, for every station, were then taken for 1858, 1859, 1860, 1861, and 1862; and the results are contained in the five following Tables.

TABLE I. Showing the Mean Annual Value

Names of Stations.	Barometer. Mean Reading reduced to the level of the sea.	Barometer. Mean Monthly Range.	Mean of the Highest Monthly Readings of a Thermometer.	Mean of the Lowest Monthly Readings of a Thermometer.	Mean Monthly Range of Temperature.	Mean of all the Highest Daily Readings.	Mean of all the Lowest Daily Readings.	Mean Daily Range.
	in.	in.	°	°	°	°	°	°
Guernsey	30.014	0.966	64.4	40.2	24.2	58.3	47.4	8.9
Helston	30.035	1.027	70.3	38.6	31.7	61.0	47.5	13.5
Truro	29.967	1.013	68.5	33.7	34.8	56.5	45.5	11.0
Teignmouth	30.007	1.052	65.8	34.9	30.9	57.1	44.5	12.6
Exeter (High Street)	30.009	1.005	69.5	34.8	34.7	58.2	44.1	14.1
Ventnor	30.063	1.030	65.8	38.2	27.6	56.6	47.0	9.6
Osborne	30.023	1.016	69.1	35.1	34.0	57.6	43.2	14.4
Worthing	30.007	0.981	63.3	36.9	26.4	55.9	45.0	10.9
Fairlight	......	......	64.6	32.9	31.7	57.8	41.7	12.1
Little Bridy	30.008	1.066	68.5	30.5	38.0	56.6	40.6	16.0
Barnstaple	30.006	0.999	68.0	34.2	33.8	57.5	44.0	13.5
Clifton	29.995	1.078	67.6	31.6	36.0	57.3	42.3	15.0
Lewisham	30.003	1.075	72.6	30.7	41.9	59.1	41.4	17.7
Royal Observatory	30.002	1.075	72.0	32.1	39.9	59.0	41.7	17.3
St. Thomas's Hospital	29.972	1.054	70.5	37.7	32.8	58.7	45.1	13.6
St. John's Wood	29.919	1.033	70.9	32.8	38.1	58.3	41.8	16.5
Guildhall	29.954	1.049	68.3	36.8	31.5	56.9	43.8	13.1
Whitehall	30.019	1.030	67.8	36.0	31.8	56.0	44.6	11.4
Camden Town	30.092	1.073	71.9	32.5	39.4	58.4	41.5	16.9
Battersea	30.005	1.051	71.5	30.6	40.9	57.4	40.2	17.2
Paddington	30.011	1.049	72.9	33.0	39.9	58.6	42.8	15.7
Rose Hill	30.019	1.049	69.1	29.5	39.6	57.0	39.7	17.3
Hartwell House	29.968	1.086	72.9	29.6	43.3	60.1	40.5	19.6
Hartwell Rectory	29.970	1.066	73.6	31.1	42.5	57.1	41.1	16.0
Great Berkhampstead	30.011	1.083	69.9	28.2	41.7	56.2	39.5	16.9
Gloucester	29.922	1.084	71.0	30.6	40.4	58.1	41.8	16.3
Royston	30.021	1.075	71.9	30.0	41.9	57.5	40.7	16.8
Cardington	30.002	1.105	70.9	29.9	41.0	57.2	40.7	16.5
Bedford	29.989	1.113	72.3	32.2	40.1	59.1	42.9	16.2
Hereford	30.033	1.091	71.2	30.0	41.2	58.5	49.4	18.1
Lampeter	30.007	1.107	68.7	26.7	42.0	57.1	40.3	16.8
Norwich	30.011	1.118	69.0	30.9	38.1	56.4	41.5	14.9
Grantham	30.002	1.176	68.1	32.4	35.7	55.1	42.3	12.8
Belvoir Castle	29.951	1.154	70.8	27.6	43.2	56.6	39.7	16.9
Derby	29.970	1.136	66.2	30.0	36.2	54.9	40.9	14.0
Holkham	30.002	1.111	61.8	28.4	33.4	55.2	40.9	14.3
Nottingham	30.001	1.194	72.5	28.3	44.2	58.4	40.2	18.2
Hawarden	29.932	1.154	62.0	33.3	28.7	55.1	43.0	12.0
Liverpool	30.034	1.126	65.8	37.8	28.0	56.1	46.0	10.1
Manchester	29.982	1.239	71.5	29.3	42.2	57.3	40.7	16.6
Wakefield	29.997	1.289	70.9	28.2	42.7	57.1	40.5	16.7
Leeds	29.983	1.247	71.6	31.1	40.5	57.5	41.2	16.3
Stonyhurst	29.946	1.225	66.6	30.3	36.3	54.3	40.7	13.6
York	29.958	1.208	64.4	29.2	35.2	55.2	40.1	13.1
Scarborough	29.983	1.163	61.9	34.6	27.3	51.1	41.9	9.2
Isle of Man	29.987	1.243	63.9	34.0	29.9	55.4	42.6	12.8
Bywell	29.934	1.250	69.7	31.5	38.2	57.0	40.8	16.2
Allenheads	28.918	1.192	63.4	28.9	34.5	51.1	38.0	13.1
North Shields	30.035	1.270	64.0	30.4	33.6	52.3	40.2	12.1

of Meteorological Elements in the Year 1858.

Mean Temperature of the Air.	Mean Temperature of the Dew-point.	Vapour. Mean Elastic Force.	Vapour. In a cubic foot of Air. Mean Weight.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity.	Mean Weight of a cubic foot of Air.	Wind. Mean estimated Strength.	Wind. Relative Proportion of N.	Wind. Relative Proportion of E.	Wind. Relative Proportion of S.	Wind. Relative Proportion of W.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
°	°	in.	grs.	gr.		grs.								in.
50.7	45.1	.311	3.7	0.8	82	540	1.9	9	6	7	8	4.7	143	25.6
53.1	49.2	.344	3.9	0.5	84	540	2.0	6	8	7	9	5.4	162	34.5
51.3	45.1	.308	3.5	0.7	80	543	2.2	8	6	8	8	6.8	195	36.2
50.7	44.5	.302	3.4	0.9	81	543	0.8	10	8	7	5	6.5	168	24.6
50.8	44.2	.298	4.2	1.0	79	541	1.7	9	5	9	7	6.4	211	32.2
51.8	47.0	.338	3.8	0.6	84	541	...	5	9	6	10	...	143	24.8
49.9	44.9	.309	3.5	0.8	84	542	0.9	5	8	7	10	6.0	130	22.3
50.2	45.5	.319	3.6	0.8	84	545	1.0	7	8	6	9	...	107	18.8
47.3	42.7	.293	3.3	0.6	88	...	1.1	6	8	7	9	4.0	127	19.9
48.4	43.4	.292	3.3	0.7	84	540	0.5	8	8	6	8	5.5	176	36.6
50.9	45.7	.317	3.5	0.8	82	543	1.6	5	9	8	8	4.0	175	33.0
48.8	43.2	.291	3.3	0.8	81	542	0.8	7	7	6	10	5.9	157	24.3
49.1	43.9	.302	3.4	0.8	82	544	...	7	7	6	10	5.6	110	17.8
49.2	42.5	.285	3.2	0.9	78	543	...	6	6	8	10	6.2	112	17.2
50.8	43.5	.295	3.3	1.1	77	543	...	7	7	6	10	...	111	15.7
49.8	44.0	.301	3.3	0.9	80	542	...	10	6	5	9	5.2	122	18.2
50.5	44.4	.306	3.4	0.9	80	545	...	...	...	...	...	...	130	18.1
50.6	42.1	.280	3.2	1.1	76	545	...	6	8	6	10	...	131	18.4
49.6	43.3	.291	3.3	0.9	79	542	...	...	...	...	...	5.5	107	18.6
48.9	44.1	.313	3.6	0.6	86	546	0.7	6	8	6	10	5.0	135	18.4
50.2	44.1	.313	3.4	0.9	81	541	...	7	8	5	10	...	114	16.6
49.3	43.5	.283	3.3	0.8	84	542	...	...	...	...	...	...	120	21.8
49.8	44.6	.310	3.5	0.8	83	539	1.0	8	5	8	9	5.7	95	17.4
48.8	42.5	.285	3.2	0.9	79	540	1.0	6	7	7	10	5.3	119	15.7
49.8	40.6	.253	2.9	1.0	76	521	0.7	8	9	7	6	5.8	144	21.5
49.7	44.0	.297	3.3	0.9	81	543	...	6	6	6	12	6.4	163	20.1
48.9	42.6	.277	3.2	0.9	74	541	...	6	8	7	9	5.5	213	20.5
49.9	42.8	.289	3.2	0.9	79	544	0.9	9	6	6	9	5.6	125	17.7
50.3	42.8	.289	3.2	1.1	76	542	...	...	...	...	...	6.3	130	20.2
49.4	44.0	.301	3.4	0.8	82	541	...	4	8	8	10	6.3	136	21.9
48.3	44.8	.309	3.4	0.4	88	539	0.6	4	8	9	9	6.1	179	36.7
48.9	43.5	.296	3.3	0.8	73	545	2.0	6	6	10	8	5.4	111	20.2
48.2	42.0	.267	3.1	0.8	91	543	...	5	8	9	8	6.3	143	23.7
47.1	43.1	.296	3.1	0.9	81	541	1.8	7	4	8	11	5.3	123	20.5
48.3	42.0	.275	3.1	0.9	79	542	...	...	...	...	...	...	...	20.8
48.4	43.0	.290	3.3	0.8	82	547	1.2	7	5	10	8	...	127	18.9
48.1	41.5	.272	3.0	1.0	77	543	0.3	...	...	...	...	6.8	134	18.9
47.0	43.2	.290	3.3	0.6	84	541	1.8	...	...	...	...	6.6	125	22.0
49.6	43.3	.290	3.3	0.9	79	545	...	...	...	...	...	6.7	140	24.3
48.5	42.3	.278	3.2	0.9	81	544	...	5	7	9	9	6.9	160	28.6
48.3	43.5	.295	3.3	0.7	84	545	1.7	6	6	8	10	6.6	173	25.3
49.3	41.6	.272	3.1	1.1	75	543	1.6	5	7	8	10	6.8	...	...
46.9	41.5	.282	3.2	0.6	84	540	1.0	7	6	6	11	6.5	188	39.2
46.7	43.4	.293	3.3	0.5	89	547	...	5	9	6	10	...	133	20.6
47.4	45.3	.303	3.8	0.3	91	545	...	6	5	8	11	...	...	...
48.3	45.2	.310	3.5	0.4	84	543	...	6	6	8	10	5.4	143	33.0
48.4	42.3	.281	3.2	0.8	79	544	1.1	5	6	6	13	4.4	166	21.8
43.5	39.1	.249	2.8	0.6	84	524	1.7	6	5	6	13	5.1	225	37.2
46.1	42.2	.278	3.1	0.5	87	545	1.7	7	5	7	11	5.4	144	40.9

TABLE II. Showing the Mean Annual Value

Names of Stations.	Barometer.		Mean of the Highest Monthly Readings of a Thermometer.	Mean of the Lowest Monthly Readings of a Thermometer.	Mean Monthly Range of Temperature.	Mean of all the Highest Daily Readings.	Mean of all the Lowest Daily Readings.	Mean Daily Range.
	Mean Reading reduced to the level of the sea.	Mean Monthly Range.						
	in.	in.	°	°	°	°	°	°
Guernsey	29·986	1·101	65·8	41·1	24·7	56·7	49·9	6·8
Helston	29·904	1·111	69·6	37·4	32·2	61·2	49·5	11·7
Truro	29·887	1·164	68·7	32·2	36·5	59·3	45·1	14·2
Exeter (Elmbrook)	29·981	1·127	67·9	33·0	34·9	57·2	43·8	13·4
Exeter (High Street)	29·959	1·107	68·8	35·4	33·4	58·6	46·6	12·0
Ventnor	29·989	1·142	65·2	38·2	27·0	57·7	47·5	10·2
Osborne	29·964	1·146	70·2	34·6	35·6	58·9	44·3	14·6
Worthing	29·922	1·111	64·2	33·6	30·6	56·2	45·3	10·9
Fairlight	......	......	65·1	33·2	31·9	55·0	43·0	12·0
Little Bridy	29·951	1·190	68·7	32·1	36·6	58·3	42·3	16·0
Barnstaple	29·924	1·176	70·8	35·0	35·8	59·9	44·6	15·3
Aldershott Camp	29·933	1·134	72·1	31·4	40·7	59·3	41·7	17·6
Clifton	29·932	1·231	68·3	32·2	36·1	57·0	42·9	14·1
Royal Observatory	29·939	1·198	72·5	32·6	39·9	60·0	43·4	16·6
St. John's Wood	29·935	1·061	73·1	31·8	41·3	59·9	42·1	17·8
Guildhall	29·898	1·082	69·0	38·2	30·8	59·4	44·6	14·8
Whitehall	29·891	1·070	74·2	36·4	37·8	60·2	45·0	15·2
Camden Town	29·943	1·200	71·9	32·5	39·4	58·9	43·4	15·4
Battersea	29·938	1·127	71·1	30·1	41·0	58·1	40·9	17·2
Paddington	29·946	1·081	71·5	34·6	36·9	59·4	43·9	15·5
Rose Hill	29·924	1·099	69·4	30·5	38·9	57·0	40·6	16·4
Oxford	29·938	1·244	68·3	31·3	37·0	57·3	42·9	14·4
Great Berkhampstead	29·925	1·150	70·3	28·7	41·6	57·6	41·5	16·1
Hartwell House	29·907	1·117	71·4	29·4	42·0	58·0	40·8	17·2
Hartwell Rectory	29·905	1·069	71·1	31·8	39·3	58·1	42·3	15·8
Royston	29·943	1·172	72·1	31·3	40·8	59·2	41·9	17·3
Gloucester	29·980	1·111	70·1	30·6	39·5	58·5	43·0	15·5
Cardington	29·930	1·118	70·6	30·4	40·2	56·4	41·4	15·0
Aspley	29·880	1·095	64·1	36·6	27·5	53·2	44·2	9·0
Hereford	29·923	1·154	71·3	29·5	41·8	60·1	41·6	18·5
Lampeter	29·924	1·166	69·1	28·2	40·9	58·0	40·1	17·9
Norwich	29·937	1·170	70·8	30·7	40·1	56·3	42·8	13·5
Grantham	29·940	1·164	69·3	32·1	37·2	55·1	42·5	12·6
Belvoir Castle	29·897	1·187	70·2	29·3	40·9	56·1	40·1	16·0
Derby	29·904	1·201	66·7	30·2	36·5	56·4	42·0	14·4
Holkham	29·917	1·139	69·0	29·6	39·4	55·9	42·9	13·0
Nottingham	29·921	1·255	70·7	28·8	41·9	58·3	40·9	17·4
Hawarden	29·839	1·263	68·2	32·8	35·4	56·2	44·5	11·7
Liverpool	29·921	1·145	65·9	37·8	28·1	56·6	44·9	11·7
Manchester	29·901	1·274	74·0	31·4	42·6	56·7	40·0	16·7
Wakefield	29·903	1·302	71·3	26·1	45·2	57·1	40·1	17·0
Leeds	29·894	1·352	72·4	31·5	40·9	57·8	41·0	16·8
Stonyhurst	29·933	1·399	67·9	23·6	44·3	54·5	41·1	13·4
York	29·921	1·235	65·0	28·1	36·9	52·5	40·0	12·5
Scarborough	29·915	1·136	63·0	34·0	29·0	51·3	44·7	6·6
Isle of Man	29·891	1·139	63·8	32·1	31·7	57·0	43·0	14·0
North Shields	29·936	1·257	73·0	32·2	40·8	52·7	40·4	12·3
St. Paul's Parsonage	29·837	1·327	66·0	28·8	37·2	54·9	41·2	13·7
Bywell	29·829	1·217	70·1	32·9	37·2	56·7	42·0	14·7
Allenheads	28·810	1·187	62·7	29·1	33·6	50·4	37·9	12·5

of Meteorological Elements in the Year 1859.

Mean Temperature of the Air.	Mean Temperature of the Dew-point.	Vapour. Mean Elastic Force.	Vapour. In a cubic foot of Air. Mean Weight.	Vapour. In a cubic foot of Air. Short of Saturation.	Mean Degree of Humidity.	Mean Weight of a cubic foot of Air.	Wind. Mean estimated Strength.	Wind. Relative Proportion of N.	Wind. Relative Proportion of E.	Wind. Relative Proportion of S.	Wind. Relative Proportion of W.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
°	°	in.	grs.	gr.		grs.								in.
52.1	47.1	.334	3.8	0.7	85	538	1.8	7	6	8	9	4.6	187	43.4
53.9	48.9	.356	3.9	0.9	83	536	2.0	6	6	7	11	6.5	160	33.5
52.4	46.2	.322	3.6	1.0	76	539	2.0	9	4	8	9	6.8	195	43.1
51.0	45.8	.317	3.5	0.8	83	541	1.3	9	5	7	9	5.2	200	29.8
51.5	45.4	.311	3.5	0.9	80	539	1.4	8	5	8	9	6.4	223	34.1
53.0	47.5	.344	3.8	0.8	83	539	...	4	7	7	12	...	180	33.0
51.4	47.2	.338	3.8	0.7	86	539	1.1	5	7	8	10	6.1	140	31.5
51.2	45.8	.324	3.6	0.8	82	548	1.7	7	7	7	9	5.6	166	29.5
49.0	45.6	.318	3.6	0.6	90	...	0.9	7	4	8	11	4.0	139	24.8
50.0	45.4	.313	3.5	0.7	83	538	0.4	7	6	6	11	5.4	196	38.8
52.5	47.3	.328	3.6	0.9	82	540	1.3	6	6	9	9	4.1	197	44.2
51.2	46.1	.321	3.6	0.8	83	536	0.6	6	6	7	11	5.6	185	30.7
49.9	44.5	.303	3.4	0.8	83	540	1.8	7	6	6	11	5.6	192	36.0
50.7	44.6	.306	3.4	0.9	80	540	...	7	8	5	10	6.4	180	30.0
51.1	45.2	.312	3.5	1.0	81	538	...	7	5	7	11	6.4	175	30.4
51.6	47.0	.339	3.8	0.7	84	541	...	...	...	...	...	...	156	23.4
52.3	43.3	.283	3.2	1.2	83	540	...	5	8	6	11	...	149	24.9
49.9	44.4	.305	3.4	0.9	80	540	...	5	6	7	12	5.9	162	27.3
50.3	44.9	.308	3.5	0.8	83	542	0.5	6	5	7	12	5.8	157	28.2
51.7	44.7	.295	3.4	1.1	77	540	...	7	6	5	12	...	123	22.7
49.5	44.5	.312	3.5	0.7	85	539	1.7	6	10	8	6	6.2	163	28.9
49.5	43.3	.295	3.2	0.9	80	540	2.0	...	...	...	...	6.9	145	27.0
49.5	43.1	.278	3.3	0.9	81	537	0.8	6	6	7	11	6.0	158	31.3
50.5	44.2	.300	3.3	0.9	80	538	0.9	7	4	9	10	5.6	...	...
49.9	44.0	.300	3.5	0.9	81	536	1.0	7	5	7	11	5.6	133	21.5
50.2	44.6	.306	3.4	0.8	81	537	...	7	2	9	12	5.9	228	25.3
50.7	46.1	.326	3.7	0.7	85	541	1.0	7	5	5	13	6.3	161	23.3
49.6	45.0	.321	3.5	0.8	84	541	0.9	7	5	8	10	6.2	...	22.4
48.8	45.3	.324	3.5	0.5	88	534	...	7	3	8	12	...	154	34.1
50.8	45.7	.323	3.7	0.7	85	539	...	7	7	8	8	6.2	148	25.3
50.1	46.3	.328	3.7	0.4	90	536	2.3	5	5	10	10	6.3	179	44.3
49.9	44.6	.317	3.5	0.6	84	542	1.5	5	5	10	10	6.0	129	24.3
48.9	43.1	.290	3.3	0.8	81	541	0.4	6	10	8	6	6.7	177	22.2
48.4	42.6	.282	3.2	0.8	81	540	1.7	6	3	10	11	5.4	149	23.1
49.2	42.5	.283	3.2	1.4	73	541	...	...	...	...	...	...	162	24.5
49.0	43.9	.298	3.3	0.7	83	540	1.2	...	...	...	...	6.7	152	26.8
49.0	43.0	.292	3.3	0.9	80	539	0.3	...	...	...	...	6.1	157	22.4
49.1	43.7	.293	3.3	0.7	82	535	1.9	5	5	8	12	6.6	126	29.9
50.1	43.9	.301	3.4	0.8	81	538	1.1	...	...	...	...	7.0	159	25.6
49.1	43.6	.292	3.3	0.8	82	541	...	4	5	9	12	6.8	184	32.7
49.0	42.7	.285	3.2	0.9	81	541	...	4	5	7	14	6.1	189	35.0
49.8	41.5	.271	3.1	1.2	74	540	1.7	7	5	9	9	7.2	167	26.5
47.3	42.9	.291	3.3	0.6	85	537	0.9	7	6	7	10	7.4	204	31.6
47.2	42.9	.283	3.2	0.6	84	543	...	5	7	6	12	...	137	20.9
47.9	46.5	.314	3.6	0.4	90	543	...	6	7	7	10	...	162	15.1
48.9	45.5	.313	3.6	0.4	90	541	1.3	6	7	6	11	5.3	159	29.0
47.3	42.5	.282	3.2	0.6	84	544	1.8	8	4	7	11	5.9	166	41.1
48.2	42.1	.285	3.1	0.9	80	542	1.8	4	7	7	12	5.2	150	44.4
48.8	41.5	.270	3.1	1.0	78	542	1.2	6	6	6	12	4.6	201	27.2
43.5	38.2	.240	2.8	0.7	83	525	1.8	6	6	6	12	6.2	273	50.1

TABLE III. Showing the Mean Annual Value

Names of Stations.	Barometer. Mean Reading reduced to the level of the sea.	Barometer. Mean Monthly Range.	Mean of the Highest Monthly Readings of a Thermometer.	Mean of the Lowest Monthly Readings of a Thermometer.	Mean Monthly Range of Temperature.	Mean of all the Highest Daily Readings.	Mean of all the Lowest Daily Readings.	Mean Daily Range.
	in.	in.	°	°	°	°	°	°
Guernsey	29·682	1·132	59·3	39·5	19·8	53·1	45·7	7·4
Helston	29·820	1·172	56·1	44·0	12·1	58·3	45·9	12·4
Truro	29·903	1·224	63·0	31·5	31·4	56·4	43·3	13·1
Exeter (Elmbrook)	29·705	1·239	63·6	33·1	30·5	54·9	42·0	12·9
Exeter (High Street)	29·716	1·265	63·6	35·1	28·5	52·4	43·0	9·4
Ventnor	29·746	1·137	51·5	36·6	14·9	53·6	36·7	16·9
Osborne	29·708	1·208	63·6	34·2	29·4	56·4	42·3	14·1
Worthing	29·876	1·103	61·5	33·4	28·1	55·2	41·8	11·4
Fairlight	......	......	59·8	32·2	27·6	51·7	40·2	11·5
Little Bridy	29·490	1·226	62·7	30·3	32·4	54·6	40·0	14·6
Barnstaple	29·842	1·280	64·8	33·7	31·1	55·5	42·9	12·6
Aldershott	29·554	1·146	65·4	30·9	34·5	55·2	39·8	15·4
Clifton	29·617	1·268	61·8	30·9	30·9	54·3	41·3	13·0
Royal Observatory	29·698	1·216	64·8	30·8	34·0	56·4	40·6	15·8
St. John's Wood	29·688	1·106	63·6	32·3	31·3	55·2	41·0	14·2
Guildhall	29·834	1·164	62·8	36·8	26·0	54·9	43·9	11·0
Whitehall	29·834	1·090	64·6	34·3	30·3	55·3	42·2	13·1
Camden Town	29·737	1·217	64·0	31·0	33·0	55·2	41·0	14·2
Battersea	29·862	1·161	63·1	31·8	31·3	53·8	40·3	13·5
Oxford	29·646	1·238	62·0	29·4	32·6	53·3	38·4	14·9
Hartwell House	29·567	1·127	64·2	29·5	34·7	54·4	39·0	15·4
Hartwell Rectory	29·530	1·170	63·3	30·1	33·2	54·7	40·1	14·6
Gloucester	29·757	1·225	64·0	30·2	33·8	54·8	38·7	15·1
Royston	29·597	1·203	64·4	28·5	35·9	54·7	39·6	16·1
Cardington	29·662	1·206	64·0	28·8	35·2	54·6	39·8	14·8
Aspley	29·780	1·145	57·8	34·6	23·2	50·0	42·3	7·7
Bedford	29·753	1·153	64·6	30·8	33·8	55·1	44·1	14·0
Lampeter	29·417	1·266	63·5	26·9	36·6	54·6	39·0	15·6
Norwich	29·803	1·188	62·8	30·6	32·2	53·8	40·9	12·9
Grantham	29·639	1·254	62·5	31·2	31·3	52·4	41·0	11·4
Belvoir Castle	29·537	1·228	63·8	28·3	35·5	53·6	39·2	14·4
Derby	29·630	1·268	61·1	28·4	32·7	52·8	40·0	12·8
Holkham	29·785	1·251	61·7	28·0	33·7	52·7	40·4	11·3
Nottingham	29·615	1·324	64·8	26·4	38·4	54·6	38·7	15·9
Hawarden	29·581	1·250	61·6	31·5	30·1	52·6	40·9	11·7
Liverpool	29·850	1·255	60·1	36·4	23·7	52·3	44·1	8·2
Manchester	29·715	1·320	63·5	28·1	35·4	54·0	38·7	15·3
Wakefield	29·707	1·300	64·4	26·6	37·8	54·1	38·4	15·7
Leeds	29·669	1·301	64·1	30·0	34·1	53·6	39·9	13·7
Stonyhurst	29·390	1·325	61·9	28·3	33·6	53·0	39·8	13·2
Ben Rhydding	29·296	1·316	60·1	29·4	30·7	51·3	38·4	12·9
York	29·752	1·317	62·0	28·8	33·2	51·2	40·7	10·5
Scarborough	29·702	1·258	58·7	33·0	25·7	48·1	41·3	6·8
Isle of Man	29·727	1·354	60·6	30·5	30·1	53·7	41·3	12·4
St. Paul's Parsonage	29·770	1·416	62·4	27·3	35·1	51·5	38·7	12·8
Bywell	29·700	1·383	63·0	30·0	33·0	53·8	40·1	13·7
Allenheads	28·332	1·330	55·7	25·4	30·2	47·5	36·0	11·5
High House	29·427	1·380	60·7	29·0	31·7	52·3	37·5	14·8
North Shields	29·754	1·300	60·0	29·4	30·6	49·2	39·1	10·1

of Meteorological Elements in the Year 1860.

Mean Temperature of the Air.	Mean Temperature of the Dew-point.	Vapour.			Mean Degree of Humidity.	Mean Weight of a cubic foot of Air.	Wind.					Mean Amount of Cloud.	Rain.	
		Mean Elastic Force.	In a cubic foot of Air. Mean Weight.	In a cubic foot of Air. Short of Saturation.			Mean estimated Strength.	Relative Proportion of N.	E.	S.	W.		Number of Days it fell.	Amount collected.
°	°	in.	grs.	gr.		grs.								in.
47.8	45.0	.306	3.5	0.5	87	540	1.7	8	6	7	9	5.0	200	48.0
48.8	41.2	.319	3.6	0.5	83	549	2.3	7	6	6	11	6.0	206	42.7
50.2	42.7	.283	3.2	0.9	75	541	2.5	10	5	5	10	5.3	235	50.7
48.0	42.3	.280	3.2	0.7	81	543	1.4	10	6	6	8	5.3	228	38.4
48.3	43.9	.295	3.3	0.6	85	542	1.5	8	4	7	11	6.8	276	35.9
49.3	43.1	.283	3.2	0.8	80	541	...	5	6	6	13	...	183	36.2
48.1	44.9	.309	3.5	0.4	88	541	0.8	6	6	7	11	6.6	148	35.5
47.4	42.8	.280	3.2	0.6	83	545	1.7	7	7	7	9	5.9	173	34.5
45.2	42.4	.276	3.3	0.2	93	...	1.1	7	5	8	10	6.1	151	29.4
46.6	43.2	.287	3.2	0.4	89	540	...	8	6	6	10	6.3	237	48.8
48.7	43.7	.292	3.3	0.7	83	543	1.4	6	6	8	10	4.3	220	50.0
47.3	42.8	.290	3.2	0.6	84	540	0.4	6	6	7	11	6.4	183	33.4
46.6	42.3	.280	3.1	0.6	83	542	0.5	7	6	8	11	6.2	221	40.6
47.0	42.4	.282	3.2	0.6	84	543	...	5	5	9	11	7.4	192	31.6
47.5	43.0	.295	3.2	0.6	84	540	...	7	5	7	11	7.5	236	34.4
48.3	44.3	.302	3.4	0.5	86	543	...	...	...	...	...	...	165	27.9
48.5	41.3	.283	3.0	0.9	77	544	...	6	6	6	12	...	175	27.5
47.4	41.4	.270	3.0	0.8	80	543	...	6	6	8	10	6.3	196	30.1
47.0	43.3	.290	3.3	0.4	87	545	1.9	9	6	8	7	6.6	165	27.7
46.2	41.9	.284	3.2	0.5	88	543	...	...	...	...	...	6.0	182	31.1
46.6	41.7	.282	3.2	0.6	86	541	0.7	9	3	9	9	6.4	115	32.3
46.4	41.3	.274	3.0	0.5	83	540	1.1	8	5	6	11	6.7	139	28.1
47.1	42.3	.285	3.1	0.6	85	543	...	7	5	5	13	7.0	193	28.1
46.0	42.2	.279	3.2	0.5	87	542	...	7	5	8	10	6.7	274	29.4
46.6	42.3	.282	3.3	0.5	85	543	1.0	8	6	7	9	6.5	196	35.3
45.4	43.0	.287	3.3	0.3	91	547	...	7	5	6	12	4.9	190	31.4
47.3	41.2	.270	3.1	0.7	80	543	...	...	...	...	...	7.3	...	...
46.0	42.8	.290	3.3	0.3	90	538	0.9	6	6	8	10	6.8	215	54.3
46.6	42.9	.287	3.2	0.5	87	545	1.6	5	5	10	10	6.2	151	33.2
45.8	41.2	.269	2.9	0.5	83	535	0.4	6	6	8	10	7.2	214	28.1
45.3	42.1	.280	3.2	0.4	89	542	2.0	6	4	9	11	6.5	188	29.1
47.2	38.8	.244	2.8	1.3	70	544	...	...	...	...	...	...	211	33.3
45.0	41.7	.275	3.1	0.5	86	544	1.5	7	6	8	9	7.0	186	33.5
46.5	40.4	.260	2.9	0.7	80	542	...	...	...	...	...	7.5	235	36.5
45.8	40.3	.257	2.9	0.7	90	542	...	...	...	...	...	7.1	151	28.8
47.5	41.5	.267	3.1	0.7	88	546	...	...	...	...	...	7.4	181	26.7
46.0	41.2	.268	3.0	0.7	82	544	...	5	7	9	9	7.0	225	35.5
46.0	40.7	.262	2.9	0.6	90	545	1.7	6	6	7	11	7.1	243	33.6
46.8	39.6	.252	2.9	0.9	78	543	1.9	8	5	7	10	7.2	220	28.2
45.3	40.6	.262	3.0	0.6	84	538	0.6	7	7	6	10	7.3	252	50.4
43.6	40.2	.256	2.9	0.4	88	540	2.3	6	5	6	13	6.9	187	37.3
45.3	42.2	.280	3.2	0.4	90	546	...	6	7	7	10	...	...	...
45.1	41.5	.270	3.0	0.4	89	546	3.0	7	7	7	9	...	108	25.3
46.2	43.5	.291	3.5	0.3	91	535	1.4	8	8	6	10	5.6	194	34.0
45.6	40.2	.258	3.0	0.6	81	545	1.7	5	9	5	11	5.8	187	37.6
45.7	40.9	.273	3.0	0.6	84	544	1.2	6	7	5	12	5.3	259	38.1
40.8	37.0	.226	2.6	0.5	86	524	1.5	6	5	10	9	7.0	294	56.8
44.4	41.4	.268	3.1	0.4	90	520	2.0	8	7	3	12	6.5	186	36.8
44.7	41.0	.264	3.0	0.4	87	525	1.6	9	6	7	8	6.5	238	37.2

TABLE IV. Showing the Mean Annual Value

Names of Stations.	Barometer.		Thermometer.					
	Mean Reading reduced to the level of the sea.	Mean Monthly Range.	Mean of the Highest Monthly Readings.	Mean of the Lowest Monthly Readings.	Mean Monthly Range of Temperature.	Mean of all the Highest Daily Readings.	Mean of all the Lowest Daily Readings.	Mean Daily Range.
	in.	in.	°	°	°	°	°	°
Guernsey	29·774	0·966	63·3	40·9	22·4	54·6	46·6	8·0
Helston	29·879	0·963	66·0	37·8	28·2	58·7	45·9	12·8
Truro	29·897	1·084	67·1	37·0	30·1	58·4	45·1	13·3
Teignmouth	29·906	1·028	65·8	34·2	31·6	58·0	45·1	12·9
Exeter, 7 Albert Terrace, St. Leonard's	29·817	1·096	69·7	32·4	37·3	58·6	43·0	15·6
Exeter, 200 High Street	29·801	1·048	66·8	34·3	32·5	57·8	44·9	12·9
Ventnor	29·827	0·997	63·0	38·1	24·9	56·1	47·3	8·8
Osborne	29·804	0·965	67·7	34·2	33·5	58·3	43·7	14·6
Little Bridy	29·575	......	68·9	...	...	57·8	42·6	15·2
Fairlight	......	......	62·8	34·5	28·3	53·9	41·9	12·0
St. John's College, near Brighton	29·808	1·076	...	31·1	...	...	42·4	...
Petersfield	......	......	68·5	30·2	38·3	57·8	41·5	16·3
Barnstaple	29·936	1·083	69·4	33·6	35·8	57·7	44·0	13·7
Aldershott	29·613	0·918	69·0	32·4	36·6	57·8	42·3	15·5
Clifton	29·708	1·112	67·3	31·2	36·1	56·9	42·8	14·1
Royal Observatory	29·800	1·051	69·3	32·6	36·7	58·6	42·2	16·4
Regent's Park	29·790	1·004	65·2	33·9	31·3	56·1	43·1	13·0
St. John's Wood	29·736	1·028	69·6	33·4	36·2	58·2	42·3	15·9
Guildhall	29·862	1·062	66·7	38·8	27·9	56·1	44·6	11·5
Battersea	29·960	1·050	68·0	33·2	34·8	57·2	42·4	14·8
Leyton	29·865	1·062	68·5	30·8	37·7	57·9	41·3	16·6
Camden Town	29·838	1·005	69·3	31·5	37·8	58·7	41·5	17·2
Oxford	29·736	0·974	66·1	31·3	34·8	56·2	42·4	13·8
Great Berkhampstead	29·565	1·047	67·1	28·2	38·9	56·6	40·9	15·7
Hartwell House	29·665	1·003	68·4	29·5	38·9	57·8	39·0	18·8
Hartwell Rectory	29·620	1·005	68·9	31·9	37·0	57·8	42·0	15·8
Gloucester	29·858	1·057	68·2	30·7	37·5	58·0	42·5	15·5
Royston	29·688	1·033	68·3	32·4	35·9	56·9	41·0	15·9
Aspley	29·402	0·948	61·4	36·7	24·7	52·1	43·8	8·3
Cardington	29·841	1·079	67·9	29·4	38·5	57·3	41·2	16·1
Bedford	29·831	1·026	68·2	32·0	36·2	57·5	42·6	14·9
Lampeter	29·503	1·112	67·7	28·0	39·7	57·4	41·2	16·2
Llandudno	29·738	0·977	63·0	38·6	24·4	54·6	45·6	9·0
Diss	29·836	0·974	69·1	30·5	38·6	57·3	41·8	15·5
Norwich	29·912	1·023	66·8	31·0	35·8	56·6	42·2	14·4
Belvoir Castle	29·610	1·059	66·7	31·1	35·6	56·0	40·3	15·7
Derby	29·731	1·037	64·0	31·2	32·8	56·7	41·0	15·7
Holkham	29·890	1·047	65·9	29·3	36·6	55·4	41·9	13·5
Nottingham	29·733	1·129	68·0	29·5	38·5	57·1	40·5	16·6
Hawarden	29·665	1·069	65·0	35·2	29·8	55·0	43·1	11·9
Kingsley Parsonage, near Frodsham, Cheshire	......	......	65·5	30·0	35·5	55·5	40·6	14·9

of Meteorological Elements in the Year 1861.

Mean Temperature of the Air.	Mean Temperature of the Dew-point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean Additional Weight required for Saturation.	Mean Degree of Humidity.	Mean Weight of a cubic foot of Air.	Wind. Mean estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
°	°	in.	grs.	gr.		grs.								in.
50·4	46·9	·324	3·8	0·5	88	540	1·7	91	74	94	106	4·7	166	31·3
51·5	47·4	·328	3·4	0·5	87	541	2·2	84	70	84	127	5·9	170	36·6
52·2	45·6	·306	3·5	1·0	79	540	2·4	109	59	95	102	7·1	192	39·8
51·1	44·6	·298	3·4	0·9	79	544	...	...	...	...	...	6·5	144	22·1
50·7	45·1	·301	3·5	0·8	83	541	1·3	112	75	86	92	5·2	185	28·4
50·5	45·4	·304	3·5	0·7	85	541	0·9	101	64	103	97	6·4	214	27·7
51·7	...	...	...	...	...	...	...	43	94	87	141	...	153	27·4
50·6	48·1	·336	3·9	0·4	88	540	0·8	60	73	108	124	5·7	...	25·9
49·3	45·2	·302	3·6	0·5	86	540	0·9	76	68	96	125	6·3	204	37·1
47·5	45·2	·302	3·5	0·4	91	540	0·9	78	76	83	128	6·0	137	29·1
50·8	45·6	·306	3·6	0·8	85	541	...	71	68	114	112	6·4	...	...
49·0	44·0	·288	3·0	0·8	85	...	...	...	...	...	...	...	141	34·5
50·9	46·7	·324	2·5	0·6	85	534	1·5	71	71	111	112	4·9	182	38·c
49·6	43·9	·289	3·5	0·7	83	539	0·5	71	71	93	130	6·1	139	22·c
48·8	44·2	·290	3·4	0·6	85	541	0·4	78	74	86	127	8·5	195	30·7
49·4	44·3	·291	3·4	0·7	83	542	...	64	67	97	137	6·8	146	20·8
48·9	43·8	·288	3·4	0·7	84	542	...	...	...	...	...	...	...	...
50·3	44·0	·290	3·4	0·9	79	540	...	70	68	90	137	7·5	172	19·8
50·1	46·0	·311	3·6	0·6	86	542	...	...	...	...	...	...	145	21·c
49·3	44·2	·291	3·4	0·7	83	545	0·7	66	76	98	125	5·4	157	21·8
49·0	43·8	·286	3·4	0·7	83	543	...	81	74	66	144	5·8	179	19·9
49·6	44·2	·291	3·4	0·8	82	543	...	...	...	...	...	6·0	157	22·3
48·6	43·7	·287	3·4	0·7	83	541	...	...	...	...	...	7·1	151	23·3
48·0	42·4	·271	3·2	0·7	82	540	0·7	80	66	100	119	6·3	172	23·9
47·2	43·3	·280	3·3	0·8	81	540	0·9	78	46	118	123	6·1	...	19·3
49·7	43·8	·286	3·4	0·7	83	539	1·0	73	62	97	133	6·0	...	18·2
49·9	44·4	·293	3·4	0·7	82	542	...	83	74	61	147	6·0	147	23·6
48·5	42·8	·275	3·3	0·7	84	541	...	79	48	103	135	6·2	224	19·8
49·4	44·0	·290	3·2	0·6	85	536	...	70	60	80	155	4·1	166	23·7
48·7	44·0	·290	3·3	0·8	82	543	1·1	83	69	82	131	6·6	161	19·6
49·6	42·6	·273	3·3	1·0	77	541	...	...	...	...	...	6·7	159	18·4
48·6	44·2	·290	3·4	0·6	85	539	0·6	59	72	115	119	6·5	180	43·9
50·4	44·4	·293	3·4	0·6	78	540	0·8	53	71	55	186	5·2	...	...
48·7	43·3	·280	3·3	0·8	82	544	...	81	55	124	105	5·8	...	20·0
48·4	44·2	·290	3·4	0·6	85	541	1·6	...	...	...	...	6·6	131	22·2
47·9	43·7	·284	3·1	0·6	84	541	2·0	65	25	143	132	5·9	154	23·6
49·6	41·0	·257	2·6	1·3	68	541	...	...	...	...	...	...	187	22·3
48·2	43·3	·280	3·2	0·7	83	544	1·3	88	56	113	108	6·5	133	21·7
48·4	43·6	·284	3·3	0·7	83	543	0·3	71	62	94	138	7·1	174	22·7
47·8	41·9	·266	3·0	0·8	79	542	2·0	81	75	83	126	...	141	21·8
47·6	42·8	·275	3·1	0·6	84	...	...	53	73	122	117	6·3	201	29·2

TABLE IV. Showing the Mean Annual Value

Names of Stations.	Barometer. Mean Reading reduced to the level of the sea.	Barometer. Mean Monthly Range.	Thermometer. Mean of the Highest Monthly Readings.	Thermometer. Mean of the Lowest Monthly Readings.	Thermometer. Mean Monthly Range of Temperature.	Thermometer. Mean of all the Highest Daily Readings.	Thermometer. Mean of all the Lowest Daily Readings.	Thermometer. Mean Daily Range.
	in.	in.	°	°	°	°	°	°
Liverpool	29·918	1·040	63·7	38·3	25·4	55·7	46·1	9·6
Wakefield	29·795	1·130	68·9	27·9	41·0	55·8	39·6	16·2
Thelwall	29·802	1·119	64·6	30·6	34·0	54·3	41·2	13·1
Leeds	29·762	1·058	67·0	29·8	37·2	54·0	40·3	13·7
Stonyhurst	29·472	1·104	63·7	30·3	33·4	54·6	41·1	13·5
Otley	29·668	1·118	64·7	33·1	31·6	52·8	41·9	10·9
York	29·837	1·048	66·1	31·7	34·4	...	...	...
Scarborough	29·836	0·955	63·8	33·7	30·1	51·3	42·6	8·7
St. Paul's Parsonage, near Silloth, Cumberland	29·840	1·142	65·4	29·3	36·1	54·7	41·1	13·6
Bywell	29·765	1·084	66·8	31·4	35·4	54·4	41·4	13·0
Allenheads	28·427	1·035	60·6	27·2	33·4	49·7	36·9	12·8
North Shields	29·816	1·103	62·9	31·2	31·7	52·1	41·0	11·1
High House, near Alnwick	29·432	1·048	64·7	32·0	32·7	53·5	39·0	14·5

TABLE V. Showing the Mean Annual Value

Guernsey	29·738	0·931	63·0	40·6	22·4	54·5	47·0	7·5
Helston	......	......	64·6	36·1	28·5	58·3	46·7	11·6
Truro	29·877	1·034	66·4	33·7	32·7	58·7	46·9	11·8
Exeter, St. Leonard's	29·687	1·006	68·7	33·6	35·1	58·9	44·5	14·4
Exeter, 200 High Street	29·742	1·008	66·5	35·9	30·6	57·6	44·3	13·3
Bournemouth	29.961	0·937	67·9	32·1	35·8	58·5	43·2	15·1
Ventnor	29·825	0·904	62·2	38·4	23·8	55·6	47·5	8·1
Osborne	29·770	0·940	66·2	33·7	32·5	57·9	44·3	13·6
Little Bridy	29·538	1·013	66·7	31·8	34·9	56·9	42·9	14·0
St. John's College, Hurstpierpoint	29·734	0·940	69·1	31·3	37·8	56·9	42·9	14·0
Worthing	29·904	0·970	63·2	35·9	27·3	55·6	45·3	10·3
Barnstaple	29·903	1·019	66·3	34·6	31·7	56·9	44·9	12·0
Aldershott Camp	29·610	0·914	68·3	32·1	36·2	56·5	42·5	14·0
Downside College, near Bath	29·381	0·976	68·4	31·2	37·2	56·4	42·0	14·4
Clifton	29·768	1·044	64·8	32·3	32·5	56·3	43·9	12·4
Royal Observatory	29·766	0·981	68·6	32·5	36·1	57·9	43·3	14·6
Battersea	29·851	1·015	66·9	31·7	35·2	56·5	43·1	13·4
Guildhall	29·858	0·939	66·1	38·7	27·4	55·9	46·0	9·9
Regent's Park	29·759	0·886	65·7	35·5	30·2	55·5	44·5	11·0
St. John's Wood	29·716	0·891	69·3	31·9	37·4	58·7	42·9	15·8

of Meteorological Elements in the Year 1861 (*continued*).

Mean Temperature of the Air.	Mean Temperature of the Dew-point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean Additional Weight required for Saturation.	Mean Degree of Humidity.	Mean Weight of a cubic foot of Air.	Wind. Mean estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
°	°	in.	grs.	gr.		grs.								in.
49·6	43·5	·283	3·4	0·8	81	544	...	...	...	...	...	6·8	168	22·5
48·4	43·8	·286	3·3	0·6	83	543	1·8	68	59	93	145	6·7	193	22·3
47·9	43·6	·284	3·3	0·6	86	543	1·4	63	76	113	113	5·7	192	29·1
48·0	41·6	·263	3·0	0·9	78	542	...	91	56	94	124	7·5	...	22·0
47·4	42·9	·276	3·0	0·6	84	538	0·7	77	69	81	138	7·1	242	49·6
46·8	41·8	·272	3·0	0·6	84	543	1·2	55	59	88	163	6·0	113	25·9
47·9	43·6	·284	3·3	0·6	85	535	...	67	69	71	158	...	159	20·9
47·3	43·3	·280	3·4	0·6	86	545	3·0	66	46	125	128	...	91	19·2
48·0	42·9	·276	3·0	0·7	82	544	2·0	48	88	67	162	5·8	176	43·3
46·9	41·8	·272	3·1	0·7	81	544	1·3	83	69	51	162	5·0	204	28·2
43·0	39·5	·249	2·9	0·4	87	539	1·8	64	48	112	141	7·2	280	51·2
47·9	43·0	·277	3·2	0·5	87	543	2·0	97	58	80	130	6·5	238	24·7
46·3	40·9	·264	2·9	0·7	81	539	2·0	70	55	40	200	5·7	177	27·5

of Meteorological Elements in the Year 1862.

50·5	46·5	·323	3·6	0·6	86	541	1·6	92	67	93	113	5·1	165	33·1
51·5	47·9	·339	3·8	0·6	86	...	...	...	...	...	...	6·4	178	38·3
52·4	46·7	·323	3·6	0·9	85	540	2·5	97	45	87	126	7·4	222	46·4
50·9	44·9	·305	3·5	0·9	83	539	1·5	114	62	81	108	5·5	211	30·8
50·9	44·7	·304	3·5	0·8	84	539	1·0	79	56	107	123	6·2	242	28·9
50·4	46·7	·325	3·7	0·6	87	542	...	75	54	86	150	4·5	132	28·9
51·6	...	...	...	...	...	...	...	...	...	...	...	...	163	31·8
50·5	47·9	·339	3·8	0·4	84	540	0·8	69	73	96	127	6·8	139	30·6
49·2	45·3	·309	3·6	0·5	87	538	0·8	82	60	80	143	6·8	214	37·0
49·8	44·9	·306	3·5	0·7	84	540	1·3	84	64	96	121	6·2	225	30·1
50·1	45·3	·309	3·5	0·7	85	538	1·1	117	65	72	111	6·0	198	32·9
50·6	46·4	·321	3·6	0·6	86	542	1·4	60	62	104	119	4·7	213	43·7
48·8	45·0	·306	3·5	0·7	87	538	0·5	77	75	81	132	...	148	...
48·1	45·9	·309	3·5	0·5	89	534	0·5	78	60	109	118	6·4	174	45·9
48·9	43·9	·294	3·3	0·7	83	524	0·3	68	74	78	145	...	209	35·7
49·6	44·9	·306	3·4	0·7	85	541	...	65	59	103	138	7·7	179	26·2
49·1	44·7	·306	3·5	0·6	86	541	0·9	59	77	94	135	6·1	190	28·1
50·5	46·9	·315	3·6	0·7	85	541	...	...	...	...	...	...	170	25·3
48·9	44·6	·304	3·4	0·6	85	542	...	...	...	...	...	...	...	...
50·3	44·3	·299	3·4	0·9	80	539	...	70	62	87	146	...	197	28·7

TABLE V. Showing the Mean Annual Value

Names of Stations.	Barometer.		Thermometer.					
	Mean Reading reduced to the level of the sea.	Mean Monthly Range.	Mean of the Highest Monthly Readings.	Mean of the Lowest Monthly Readings.	Mean Monthly Range of Temperature.	Mean of all the Highest Daily Readings.	Mean of all the Lowest Daily Readings.	Mean Daily Range.
	in.	in.	°	°	°	°	°	°
Camden Town	29·836	0·968	68·1	32·0	36·1	57·5	43·0	14·5
Leyton	29·830	......	68·2	31·2	37·0	57·5	43·5	14·0
Radcliffe Observatory, Oxford...	29·687	1·027	65·3	31·4	33·9	56·0	43·6	12·4
Great Berkhampstead	29·535	0·971	66·8	28·6	38·2	56·4	42·1	14·3
Hartwell House	29·623	0·979	68·2	30·9	37·3	57·9	42·4	15·5
Hartwell Rectory	29·597	0·944	66·9	30·6	36·3	53·6	42·4	11·2
Aspley	29·346	0·972	60·6	35·7	24·9	52·3	44·5	7·8
Royston	29·666	0·996	67·4	31·4	36·0	57·5	43·3	14·2
Cardington	29·815	1·020	67·3	30·1	37·2	57·2	42·3	14·9
Lampeter	29·450	1·043	65·6	27·5	38·1	56·8	41·3	15·5
Diss (Norfolk)	29·817	1·032	67·8	33·1	34·7	57·0	43·2	13·8
Grantham	29·710	1·067	65·2	32·1	33·1	54·7	43·4	11·3
Derby..................................	29·689	1·113	66·6	32·3	34·3	57·1	43·7	13·4
Holkham	29·872	1·046	66·4	30·7	35·7	55·0	43·9	11·1
Nottingham	29·725	1·115	63·2	28·7	34·5	56·7	40·9	15·8
Hawarden	29·606	1·066	63·2	34·5	28·7	57·3	43·7	13·6
KingsleyParsonage,nr.Frodsham	29·671	1·120	65·0	30·0	35·0	54·5	40·6	13·9
Thelwall, near Warrington	29·783	1·173	64·1	30·0	34·1	55·4	41·5	13·9
Liverpool	29·890	1·108	62·4	38·4	24·0	55·1	46·3	8·8
Wakefield Prison	29·742	1·151	67·0	28·2	38·8	55·2	40·3	14·9
Leeds	29·545	1·109	63·4	31·4	32·0	53·2	40·9	12·3
Bradford	29·496	1·139	61·6	35·5	26·1	53·1	44·3	8·8
Stonyhurst..........................	29·440	1·159	63·0	32·2	30·8	54·0	41·7	12·3
Otley	29·646	1·061	61·3	33·5	27·8	51·7	42·6	9·1
Harrogate	29·409	1·115	62·8	32·0	30·8	53·3	41·2	12·1
Scarborough	29·809	1·098	61·1	35·8	25·3	51·3	42·9	8·4
St. Paul's Parsonage, near Silloth	29·816	1·287	65·3	30·2	35·1	54·0	41·3	12·7
Bywell	29·742	1·101	65·6	31·6	34·0	55·0	41·1	13·9
Allenheads............................	28·385	1·114	59·4	27·1	32·3	49·7	37·6	12·1
North Shields	29·805	1·224	61·4	31·9	29·5	51·7	41·3	10·4
High House, Alnwick	29·396	1·143	63·0	30·6	32·4	52·7	39·2	13·5

The barometer-readings in the years 1860, 1861, and 1862

of Meteorological Elements in the Year 1862 (*continued*).

Mean Temperature of the Air.	Mean Temperature of the Dew-point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean Additional Weight required for Saturation.	Mean Degree of Humidity.	Mean Weight of a cubic foot of Air.	Wind. Mean estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.
°	°	in.	grs.	gr.		grs.								in.
49·0	43·9	·294	3·3	0·8	82	541	...	73	61	94	137	...	176	28·8
49·8	45·2	·309	3·5	0·7	85	541	0·5	83	77	64	141	6·8	164	22·9
48·9	44·5	·299	3·4	0·6	84	541	1·5	83	48	112	121	7·7	180	27·0
48·4	43·1	·285	3·3	0·8	83	540	0·8	77	63	89	146	6·5	180	27·6
49·8	44·2	·299	3·4	0·8	82	539	0·9	89	56	118	102	7·2	...	24·3
48·8	44·1	·298	3·4	0·7	85	539	0·9	69	78	94	125	7·5	119	22·5
47·8	44·6	·303	3·4	0·4	89	535	...	...	...	...	...	...	177	26·8
48·5	44·2	·298	3·4	0·6	87	540	...	93	46	86	140	6·9	240	23·9
49·1	43·5	·289	3·4	0·7	84	542	1·1	83	64	88	130	5·8	181	22·2
48·3	44·1	·295	3·3	0·6	85	538	0·6	55	75	120	115	7·1	177	43·4
49·0	44·5	·299	3·3	0·7	85	540	...	82	65	124	94	6·5	186	23·1
48·0	43·7	·289	3·3	0·6	84	541	0·4	78	55	110	122	7·6	190	21·9
49·9	40·0	·263	2·9	1·2	71	542	...	...	...	...	...	...	205	25·9
48·4	44·1	·299	3·3	0·6	86	544	...	78	62	113	112	7·4	162	22·9
48·7	42·7	·288	3·2	0·9	81	541	0·7	87	66	92	119	7·1	181	23·5
48·0	43·1	·284	3·2	0·5	84	541	...	...	...	...	...	7·3	150	30·4
47·6	43·0	·284	3·1	0·6	84	542	0·5	45	82	109	129	7·1	225	37·3
48·0	43·4	·287	3·3	0·6	85	543	1·2	54	76	113	122	6·4	218	35·9
49·5	43·6	·292	3·3	0·8	82	543	1·3	...	...	...	...	7·5	188	29·5
48·2	43·4	·288	3·3	0·7	84	542	1·6	90	73	86	116	7·1	202	27·0
46·7	42·3	·277	3·1	0·6	85	541	1·3	63	69	112	111	7·8	191	21·7
48·1	43·6	·294	3·3	0·7	85	538	1·8	83	74	85	123	7·2	220	25·2
47·3	42·7	·290	3·2	0·6	88	538	0·6	84	81	72	128	7·7	232	53·6
46·3	42·2	·276	3·1	0·5	85	542	1·2	78	74	56	157	6·1	137	30·5
46·2	42·1	·275	3·1	0·6	85	538	0·8	98	74	77	116	4·0	202	33·0
...	...	...	...	...	...	...	...	64	82	106	113	...	...	20·3
47·6	42·5	·278	3·2	0·7	83	535	1·3	36	97	84	148	6·3	163	44·0
47·3	41·7	·271	3·1	0·7	81	543	...	61	85	61	158	5·5	205	26·3
42·7	39·2	·245	2·9	0·4	89	525	1·5	54	41	133	137	7·0	289	45·3
45·9	42·3	·275	3·1	0·5	88	546	1·9	93	57	81	134	6·4	248	31·5
45·6	42·6	·282	3·2	0·4	87	541	1·8	70	80	54	161	6·7	191	31·0

have not been reduced to the level of the sea.

TABLE VI. Showing the Mean Annual Value of Meteorological Latitude.

Years.	Parallels of Latitude.	Barometer. Mean Reading reduced to the level of the sea.	Barometer. Mean Monthly Range.	Thermometer. Mean of the Highest Monthly Readings.	Thermometer. Mean of the Lowest Monthly Readings.	Thermometer. Mean Monthly Range of Readings.	Thermometer. Mean of all the Highest Daily Readings.	Thermometer. Mean of all the Lowest Daily Readings.	Thermometer. Mean Daily Range.	Mean Temperature of the Air.	Mean Temperature of the Dew-point.
	Between the Latitudes	in.	in.	°	°	°	°	°	°	°	°
1858	49° and 50°	30·014	0·966	64·4	40·2	24·2	56·3	47·4	8·9	50·7	45·1
	50° and 51°	30·014	1·023	67·2	35·0	32·2	57·0	44·3	12·7	50·4	45·1
	51° and 52°	29·994	1·058	70·6	33·0	37·6	57·8	42·5	15·3	49·9	43·9
	52° and 53°	29·977	1·139	67·1	28·8	38·3	57·0	41·3	15·7	48·6	43·1
	53° and 54°	29·990	1·212	67·5	31·3	36·2	55·8	41·6	14·2	46·6	42·7
	54° and 55°	29·971	1·223	64·5	31·9	32·6	53·3	40·7	12·6	46·7	42·2
1859	49° and 50°	29·986	1·101	65·8	41·1	24·7	56·7	49·9	6·8	51·1	47·1
	50° and 51°	29·981	1·149	68·3	34·0	34·3	58·2	44·7	13·5	51·4	46·3
	51° and 52°	29·929	1·128	71·1	32·0	39·1	59·4	41·8	17·6	50·5	44·6
	52° and 53°	29·916	1·170	70·0	30·0	40·0	56·6	41·6	15·0	49·3	42·0
	53° and 54°	29·916	1·281	69·2	30·1	39·1	56·0	41·6	14·4	48·9	41·6
	54° and 55°	29·870	1·210	66·2	31·5	34·7	54·6	51·5	13·1	47·4	42·7
1860	49° and 50°	29·897	1·132	59·3	39·5	19·8	53·1	45·7	7·4	47·8	45·0
	50° and 51°	29·900	1·196	60·7	34·5	26·2	54·6	41·7	12·9	48·0	43·0
	51° and 52°	29·870	1·182	63·7	31·8	31·9	54·8	37·5	17·3	47·3	42·4
	52° and 53°	29·846	1·231	63·0	29·3	33·7	53·6	40·0	13·6	46·2	41·7
	53° and 54°	29·828	1·298	62·2	30·0	32·2	52·7	40·0	12·7	45·8	40·8
	54° and 55°	29·790	1·350	60·1	29·2	30·9	50·8	39·1	11·9	44·6	40·8
1861	49° and 50°	29·774	0·966	63·3	40·9	22·4	54·6	46·6	8·0	50·4	46·9
	50° and 51°	29·817	1·032	66·4	34·7	21·7	57·5	44·1	13·4	50·6	45·8
	51° and 52°	29·764	1·029	68·1	32·2	35·9	57·3	42·7	14·6	49·1	44·1
	52° and 53°	29·731	1·036	66·2	31·5	34·7	56·1	42·0	14·1	49·0	43·4
	53° and 54°	29·708	1·029	65·2	31·1	34·1	53·9	41·6	12·8	47·6	42·7
	54° and 55°	29·519	1·061	64·1	30·8	33·3	52·5	40·3	12·2	46·5	41·8
1862	49° and 50°	29·738	0·931	63·0	40·6	22·4	54·5	47·0	7·5	50·5	46·5
	50° and 51°	29·767	0·973	66·5	34·1	32·4	57·7	44·8	12·9	50·8	46·1
	51° and 52°	29·709	1·039	67·7	33·1	34·6	57·1	43·5	13·6	49·9	45·1
	52° and 53°	29·676	1·045	65·5	31·3	34·2	56·0	43·0	13·0	48·5	44·6
	53° and 54°	29·615	1·126	63·3	33·2	30·1	53·5	41·7	11·8	47·3	42·8
	54° and 55°	29·429	1·174	62·9	30·6	32·3	52·6	40·1	12·5	45·8	41·6

Elements in the Years 1858 to 1862, for different Parallels of

Mean Elastic Force of Vapour.	Mean Weight of Vapour to cubic foot of Air.	Mean Additional Weight required for Saturation.	Mean Degree of Humidity.	Mean Weight of a cubic foot of Air.	Wind. Mean estimated Strength.	Wind. Relative Proportion of N.	E.	S.	W.	Mean amount of Cloud.	Rain. Number of Days it fell.	Rain. Amount collected.	Number of Stations.
in.	grs.	gr.		grs.								in.	
·301	3·7	0·8	82	540	1·9	9	6	7	8	4·7	143	25·6	1
·301	3·6	0·7	83	542	1·2	7	8	7	7	5·8	157	27·7	9
·287	3·4	0·8	80	542	1·2	8	7	7	9	5·1	161	19·3	14
·278	3·2	0·7	80	543	1·1	7	5	8	10	6·3	145	27·2	13
·274	3·2	0·8	80	543	1·5	6	7	7	10	6·5	153	26·6	8
·279	3·1	0·4	67	539	1·5	6	5	7	11	5·0	169	33·2	4
·334	3·8	0·7	85	538	1·8	7	6	8	9	4·6	187	43·4	1
·315	3·6	0·8	83	539	1·3	7	6	7	10	5·5	167	34·1	10
·295	3·4	0·8	81	539	1·1	6	6	7	9	6·1	175	26·4	14
·267	3·4	0·9	81	538	0·9	6	6	9	9	6·1	154	28·1	12
·263	3·2	0·8	82	537	1·1	5	5	7	11	7·0	157	30·0	8
·274	3·2	0·6	84	540	1·3	6	6	6	11	4·5	200	34·5	5
·306	3·5	0·5	84	540	1·7	8	5	7	10	5·0	200	48·0	1
·277	3·3	0·5	84	543	1·6	7	5	8	10	6·0	187	40·0	9
·273	3·1	0·6	83	542	1·0	6	5	7	11	6·3	182	33·0	13
·266	3·2	0·5	84	539	1·2	6	5	8	9	6·7	203	32·6	11
·255	3·0	0·6	86	543	0·8	6	6	7	11	7·1	208	34·3	8
·255	3·0	0·4	87	543	1·8	7	6	6	10	6·1	209	39·9	6
·324	3·8	0·5	88	540	1·7	8	6	8	8	4·7	166	31·3	1
·308	3·6	0·7	85	541	1·3	6	7	7	10	6·2	175	29·7	10
·290	3·4	0·7	82	540	0·8	6	5	8	11	6·4	162	24·1	15
·281	3·2	0·7	81	541	0·7	6	5	9	10	6·1	160	23·8	13
274	3·1	0·7	83	540	0·6	6	5	7	12	5·2	176	29·5	9
·264	2·6	0·6	84	540	2·0	6	5	7	12	6·0	194	32·4	6
·323	3·6	0·6	86	541	1·6	7	6	8	9	5·1	165	33·1	1
·319	3·6	0·7	85	540	1·3	7	5	8	10	6·2	181	33·5	10
·309	3·4	0·7	84	540	0·8	6	6	7	11	6·8	176	29·5	17
·291	3·3	0·7	83	540	0·7	7	5	9	9	6·6	200	24·8	13
·275	3·2	0·6	85	540	1·1	6	6	7	11	6·7	203	31·6	13
·270	3·1	0·6	86	540	1·6	5	6	7	12	6·3	219	35·6	6

TABLE VII. Showing the Mean Annual Value of Meteorological

Parallels of Latitude.	Years.	Barometer. Mean Reading reduced to the level of the sea.	Barometer. Mean Monthly Range.	Thermometer. Mean of the Highest Monthly Readings.	Thermometer. Mean of the Lowest Monthly Readings.	Thermometer. Mean Monthly Range of Readings.	Thermometer. Mean of all the Highest Daily Readings.	Thermometer. Mean of all the Lowest Daily Readings.	Thermometer. Mean Daily Range.	Mean Temperature of the Air.	Mean Temperature of the Dew-point.
Between the Latitudes		in.	in.	°	°	°	°	°	°	°	°
49° and 50° ...	1855	29·930	1·006	61·3	39·3	22·0	53·7	46·3	7·4	48·6	44·2
	1856	29·947	1·114	62·8	41·4	21·4	55·6	48·3	7·3	50·5	45·7
	1857	29·977	1·044	64·5	42·5	22·0	57·6	49·0	8·6	51·9	46·1
	1858	30·014	0·966	64·4	40·2	24·2	56·3	47·4	8·9	50·7	45·1
	1859	29·986	1·101	65·8	41·1	24·7	56·7	49·9	6·8	51·1	47·1
	1860	29·897	1·132	59·3	39·5	19·8	53·1	45·7	7·4	47·8	45·0
	1861	29·986	0·966	63·3	40·9	22·4	54·6	46·6	8·0	50·4	46·9
	1862	29·952	0·931	63·0	40·6	22·4	54·5	47·0	7·5	50·5	46·5
50° and 51° ...	1855	29·948	0·988	66·2	33·1	33·1	56·2	43·2	13·0	48·8	43·2
	1856	29·947	1·098	66·1	34·9	31·2	57·9	45·5	12·4	49·8	45·5
	1857	30·017	1·075	66·8	36·4	30·4	58·9	46·4	12·5	52·1	47·8
	1858	30·014	1·023	67·2	35·0	32·2	57·0	44·3	12·7	50·4	45·1
	1859	29·981	1·149	68·3	34·0	34·3	58·2	44·7	13·5	51·4	46·3
	1860	29·900	1·196	60·7	34·5	26·2	54·6	41·7	12·9	48·0	43·0
	1861	30·012	1·032	66·4	34·7	31·7	57·5	44·1	13·4	50·6	45·8
	1862	29·962	0·973	66·5	34·1	32·4	57·7	44·8	12·9	50·8	46·1
51° and 52° ...	1855	29·946	1·020	67·3	28·4	38·9	55·2	40·6	14·6	46·9	42·0
	1856	29·944	1·146	69·0	30·6	38·4	56·9	42·2	14·7	48·8	43·8
	1857	29·992	1·093	69·9	33·2	36·7	59·2	43·8	15·4	50·8	45·3
	1858	29·994	1·058	70·6	33·0	37·6	57·8	42·5	15·3	49·9	43·9
	1859	29·929	1·128	71·1	32·0	39·1	59·4	41·8	17·6	50·6	44·5
	1860	29·870	1·182	63·7	31·8	31·9	54·8	37·5	17·3	47·3	42·4
	1861	29·951	1·029	68·1	32·2	35·9	57·3	42·7	14·6	49·1	44·1
	1862	29·896	1·039	65·5	31·3	34·2	56·0	43·0	13·0	48·5	44·6
52° and 53° ...	1855	29·953	1·055	65·6	27·6	38·0	54·5	39·5	15·0	46·2	41·1
	1856	29·937	1·159	65·9	30·2	35·7	55·1	42·2	12·9	47·9	42·7
	1857	29·972	1·122	67·2	32·4	34·8	57·2	44·0	13·2	49·9	44·2
	1858	29·977	1·139	67·1	28·8	38·3	57·0	41·3	15·7	48·6	43·1
	1859	29·916	1·170	70·0	30·0	40·0	56·6	41·6	15·0	49·3	42·0
	1860	29·846	1·231	63·0	29·3	33·7	53·6	40·0	13·6	46·2	41·7
	1861	29·928	1·036	66·2	31·5	34·7	56·1	42·0	14·1	49·0	43·4
	1862	29·873	1·045	65·5	31·3	34·2	56·0	43·0	13·0	48·5	44·6
53° and 54° ...	1855	29·934	1·119	63·8	29·4	34·4	53·4	40·4	13·0	46·1	40·7
	1856	29·930	1·102	65·9	30·2	35·7	55·1	42·2	12·9	47·9	42·7
	1857	29·968	1·179	67·2	32·4	34·8	57·2	44·0	13·2	49·9	44·2
	1858	29·990	1·212	67·5	31·3	36·2	55·8	41·6	14·2	46·6	42·7
	1859	29·916	1·281	69·2	30·1	39·1	56·0	41·6	14·4	48·9	41·6
	1860	29·828	1·298	62·2	30·0	32·2	52·7	40·0	12·7	45·8	40·8
	1861	29·857	1·029	65·2	31·1	34·1	53·9	41·1	12·8	47·6	42·7
	1862	29·864	1·126	63·3	33·2	30·1	53·5	41·7	11·8	47·3	42·8
54° and 55° ...	1855	29·957	1·168	60·3	31·7	28·6	51·1	41·1	10·0	45·2	41·0
	1856	29·919	1·119	61·3	33·1	28·2	52·0	42·3	9·7	46·0	42·1
	1857	29·944	1·147	63·6	33·3	30·3	54·0	43·4	10·6	47·6	44·1
	1858	29·971	1·223	64·5	31·9	32·6	53·3	40·7	12·6	46·7	42·2
	1859	29·870	1·210	66·2	31·5	34·7	54·6	51·5	13·1	47·4	42·7
	1860	29·790	1·350	60·1	29·2	30·9	50·8	39·1	11·9	44·6	40·8
	1861	29·886	1·061	64·1	30·8	33·3	52·5	40·3	12·2	46·5	41·8
	1862	29·847	1·174	62·9	30·6	32·3	52·6	40·1	12·5	45·8	41·6

Elements in the Years 1855 to 1862, between the Latitudes 49° & 55°.

Mean Elastic Force of Vapour.	Mean Weight of Vapour in a cubic foot of Air.	Mean additional Weight required for Saturation.	Mean degree of Humidity.	Mean Weight of a cubic foot of Air.	Wind.					Mean amount of Cloud (0—10).	Rain.		Number of Stations.
					Mean estimated Strength.	Relative Proportion of					Number of Days it fell.	Amount collected.	
						N.	E.	S.	W.				
in.	grs.	gr.		grs.								in.	
·316	3·6	0·6	86	539	1·7	...	...	...	...	5·4	134	28·8	2
·315	3·6	0·7	84	541	2·0	...	...	...	...	5·0	152	34·0	1
·327	3·7	0·8	82	539	1·6	...	...	...	...	4·7	151	31·7	1
·301	3·7	0·8	82	540	1·9	9	6	7	8	4·7	143	25·0	1
·334	3·8	0·7	85	538	1·3	7	6	8	9	4·6	187	43·4	1
·306	3·5	0·5	84	540	1·7	8	5	7	10	5·0	200	48·0	1
·324	3·8	0·5	88	540	1·7	7	6	8	9	4·7	166	31·3	1
·323	3·6	0·6	86	541	1·6	8	5	8	9	5·1	165	33·1	1
·308	3·5	0·7	83	540	1·4	...	...	...	...	6·3	154	26·9	9
·314	3·6	0·9	82	542	1·5	7	8	6	9	3·4	162	33·7	9
·344	3·9	0·7	86	540	1·0	6	8	7	9	5·5	166	33·7	5
·301	3·6	0·7	83	542	1·2	7	8	8	7	5·8	157	27·7	9
·315	3·6	0·8	83	539	1·3	7	6	7	10	5·5	167	34·1	10
·277	3·3	0·5	84	543	1·6	7	5	8	10	6·0	187	40·0	9
·308	3·6	0·7	85	541	1·3	7	6	8	9	6·2	175	29·7	10
·319	3·6	0·7	85	540	1·3	7	5	8	10	6·2	181	33·5	10
·297	3·6	0·7	85	539	1·0	...	...	...	...	6·8	148	23·3	11
·293	3·4	0·8	83	540	1·0	8	6	7	9	6·6	159	24·4	10
·314	3·5	0·9	83	540	1·1	6	6	8	10	6·4	155	25·0	11
·287	3·4	0·8	80	542	1·2	8	7	7	8	5·1	161	19·3	14
·295	3·4	0·8	81	539	1·1	6	6	7	9	6·1	175	26·4	14
·273	3·1	0·6	83	542	1·0	6	5	7	11	6·3	182	33·0	13
·290	3·4	0·7	82	540	0·8	6	6	8	10	6·4	162	24·1	15
·296	3·3	0·6	83	540	0·7	6	5	8	11	6·6	176	29·8	17
·289	3·3	0·6	85	541	1·0	...	...	...	...	6·7	167	23·5	11
·293	3·2	0·7	83	543	1·4	7	5	7	11	7·4	163	28·9	12
·301	3·4	0·8	84	543	1·2	6	5	9	10	7·2	171	32·2	10
·278	3·2	0·7	80	543	1·1	7	5	8	10	6·3	145	27·2	13
·267	3·4	0·9	81	538	0·9	6	6	9	9	6·1	154	28·1	12
·266	3·2	0·5	84	539	1·2	7	6	8	9	6·7	203	32·6	11
·281	3·2	0·7	81	541	0·7	6	5	8	11	6·1	160	23·8	13
·291	3·3	0·7	83	540	0·7	7	5	9	9	6·6	200	24·8	13
·287	3·3	0·7	84	542	1·2	...	...	...	...	6·5	151	24·4	8
·293	3·4	0·8	83	543	1·4	7	5	8	10	7·4	163	28·9	8
·301	3·4	0·8	84	543	1·2	5	8	9	8	7·2	171	32·2	8
·274	3·2	0·8	80	543	1·5	6	7	7	10	6·5	153	26·6	8
·263	3·2	0·8	82	539	1·1	5	5	7	11	7·0	157	30·0	8
·255	3·0	0·6	86	543	0·8	6	6	7	11	7·1	208	34·3	8
·274	3·1	0·7	83	540	0·6	6	6	8	10	5·2	176	29·5	9
·275	3·2	0·6	85	540	1·1	6	6	7	11	6·7	203	31·6	13
·287	3·3	0·5	87	543	...	...	...	...	...	6·4	167	29·9	2
·275	3·1	0·5	87	540	1·9	6	6	6	12	6·6	168	38·2	3
·299	3·4	0·5	88	537	1·8	5	7	7	11	6·4	192	38·9	3
·279	3·1	0·4	67	539	1·5	6	5	7	11	5·0	169	33·2	4
·274	3·2	0·6	84	540	1·3	6	6	6	11	4·5	200	34·5	5
·255	3·0	0·4	87	543	1·8	7	6	6	10	6·1	209	39·9	6
·264	2·6	0·6	84	540	2·0	6	5	6	13	4·5	194	32·4	6
·270	3·1	0·6	86	540	1·6	...	...	...	..	5·9	219	35·6	6

By looking over Tables I. to V., the first thing which attracts attention is the less pressure of the atmosphere with greater range of readings, proceeding northwards; the next, the much smaller range of daily and monthly temperature at sea-side stations than at inland, particularly as compared with those between the latitudes of 51° and 53°, where the extremes of temperature seem to be experienced. Then the regularity of decrease of mean temperature with increase of latitude, between stations under the same circumstances, and the near agreement of the mean temperature of places in the same latitude, though under different local circumstances; and the decrease in the fall of rain proceeding from the south coast to latitude 52°, where the smallest annual falls take place, and the increase in the amount passing from 52° to the extreme northern stations.

By grouping these results between each parallel of latitude, and taking the mean of each element in every group, Table VI. was formed, showing the mean annual value of meteorological elements in each year, 1858 to 1862. Those for the years 1855 to 1857 will be found in the Eighth Annual Report, p. 124.

By carefully looking over these several Tables, the influence of latitude is very plainly seen upon the different elements, agreeing closely year by year; this effect will, however, be better shown by grouping together the results from each parallel of latitude for the different years; and combining with them those contained in the Eighth Annual Report, Table VII. (p. 200) is formed, from which Table VIII. (on page 204) is formed by taking the mean of the numbers in each group.

By comparing the individual results in Table VII. with the numbers in Table VIII.,

We find that the pressure of the atmosphere in the year

1855 was	below	its average	south of lat. 51°	and above it north of 51°.
1856 was	„	„	„ „	
1857 was	above	„	all over the country.	
1858 was	„	„	„ „ „	
1859 was	„	„	south of lat. 51° and north of 53°.	
1860 was	below	„	all over the country.	
1861 was	above	„	south of lat. 53°	and below it north of 53°.
1862 was	below	„	all over the country.	

Taking the whole country, there was an excess of pressure of

in.	
0·010	in 1855
0·002	in 1856
0·043	in 1857
0·058	in 1858
0·002	in 1861

And there was a deficiency of pressure of—

0·002	in 1859
0·080	in 1860
0·036	in 1862

The Temperature of the Air,

In the year 1855, was below the average all over the country.
1856, was very nearly the average all over the country.
1857, was in excess everywhere.
1858, was in excess in all latitudes excepting between 53° and 54°.
1859, was in excess everywhere.
1860, was in defect everywhere.
1861, was very slightly in excess.
1862, was alternately in excess and defect by small quantities.

Taking the whole country, the temperature was in excess in the year

1857	by 1°·8
1858	by 0·3
1859	by 1·2
1861	by 0·3

It was in defect in the year

1855	by 1·6
and in the year 1860	by 1·9

And the years 1856 and 1862 were nearly of average temperature.

The Fall of Rain,

In the year 1855, was in defect everywhere.
1856, was alternately in excess and defect in the different latitudes.

In the year 1857, was generally in defect south of lat. 52°, and in excess north of 52°.
1858, was in defect everywhere.
1859, was greatly in excess in extreme south, and in defect in north.
1860, was greatly in excess in the south, and to smaller amounts everywhere.
1861, was in defect except in lat. 53½°.
1862, was alternately in excess and defect in different parallels.

TABLE VIII. Showing the Mean Value of Meteorological Elements in each Parallel of Latitude, as found from all the Observations in the Years 1855 to 1862, both inclusive.

Parallels of Latitude.	Barometer. Mean Reading reduced to the level of the sea.	Barometer. Mean of Monthly Ranges.	Thermometer. Mean of the Highest Monthly Readings.	Thermometer. Mean of the Lowest Monthly Readings.	Thermometer. Mean Monthly Range of Readings.	Thermometer. Mean of all the Highest Daily Readings.	Thermometer. Mean of all the Lowest Daily Readings.	Thermometer. Mean Daily Range.	Mean Temperature. Of the Air.	Mean Temperature. Of the Dew-point.	Mean Elastic Force of Vapour.	Mean Weight of Vapour to cubic foot of Air.
	in.	in.	°	°	°	°	°	°	°	°	in.	grs.
49° and 50°.........	29·961	1·033	63·0	40·7	22·3	55·3	47·5	7·8	50·2	45·8	·318	3·7
50° and 51°.........	29·973	1·067	66·0	34·6	30·2	57·3	44·3	12·9	50·2	45·3	·311	3·6
51° and 52°.........	29·940	1·087	68·1	31·6	36·5	56·8	41·8	15·3	48·9	43·8	·293	3·4
52° and 53°.........	29·925	1·119	66·3	30·1	36·2	55·8	41·7	14·1	48·2	42·8	·283	3·3
53° and 54°.........	29·911	1·168	65·5	30·9	34·6	54·7	41·6	13·1	47·5	42·3	·278	3·2
54° and 55°.........	29·898	1·183	63·0	31·5	31·5	52·8	42·5	11·6	46·2	42·1	·275	3·2

Parallels of Latitude.	Mean Additional Weight required for Saturation.	Mean Degree of Humidity.	Mean Weight of a cubic foot of Air.	Wind. Mean estimated Strength.	Wind.	Wind.	Wind.	Wind.	Mean amount of Cloud.	Rain. No. of Days it fell.	Rain. Amount collected.	Number of Stations.	How Situated.
	gr.		grs.								in.		
49° and 50°.........	0·7	85	539	1·7	...	...	...	...	4·9	162	31·4	1	Guernsey.
50° and 51°.........	0·7	84	541	1·3	...	...	...	...	5·6	169	32·4	9	South coast of England [chiefly.
51° and 52°.........	0·7	83	540	1·0	...	...	...	...	6·4	165	25·7	13	Across the country, mostly inland.
52° and 53°.........	0·7	83	541	1·0	...	...	...	...	6·6	170	27·6	12	
53° and 54°.........	0·7	83	542	1·1	...	...	...	...	6·7	173	29·7	9	
54° and 55°.........	0·5	81	540	...	...	...	...	...	5·7	184	35·7	4	

The mean pressure of the atmosphere at the level of the sea for the whole of England was 29·933 inches; this value was exceeded at all stations south of 52½°, and fell short at all stations north of this parallel.

The average monthly range of barometer readings for the whole of England was 1·111 inch; at stations south of 52½°, the range was less, and at those north of this parallel was greater than the average; the difference between the extreme values was as large as 0·15 inch.

The average extreme high day temperature for the whole of England was 65°·7, at Guernsey it was 2°·7 lower; between 50° and 51° and 53° and 54° the value was nearly the same as the average, between 51° and 52° it exceeded it by 2°·4, and between 54° and 55° was below it by 2°·5, the extreme high temperature at Guernsey being of very nearly the same value as that at the extreme high latitude.

The average extreme low night temperature for all England is 33°·3. At Guernsey the average of all the low night temperatures in the year is as high as 40°·7; the next in order is 34°·6, between the parallel of 50° and 51°; at all stations north of 52° the average of all the extreme low night temperatures is below 32°.

The average monthly range of temperature for England was 32°·4; at Guernsey it is 10° less; and between latitudes 51° and 52°, where the range is the greatest, it is 36°·5.

The average of all the high day temperatures for England is 55°·5; at Guernsey the value of this element differs but little from the average of all. Between the latitudes 50° and 52° this value is exceeded, and it is less at places situated north of 52°, and is 2°·7 less between the latitudes of 54° and 55°.

The average of all the low night temperatures for England was 43°·2. At Guernsey the nights were 4°·4 warmer than the average for England, and on the south coast of England they are 1°·3 warmer; but north of 51°, extending to 54°, they are nearly alike and below the average; between 54° and 55° the nights seem to be a little warmer than in the three degrees south of this parallel.

The average daily range of temperature for England was 12°·3. At Guernsey it was 7°·8; between the latitudes 50° and 51° it was nearly the same as the average; whilst between 51° and 54° it ranged from 13°·1 to 15°·3, and north of 54° it was below, being only 11°·6.

The mean annual temperature of the air for the whole of Eng-

land was 48°·7. At Guernsey, and between the latitudes 50° and 51°, it was 50°·2; between the next two pairs of parallels the mean was 0°·3 and 0°·4 in defect respectively; between the latitudes 53° and 54° the mean was 47°·5, and north of 54° was 46°·4.

By taking the difference between each pair of numbers, leaving out Guernsey and between the latitudes 50° and 51°, the former of which is surrounded by water, and the latter along the south coast, it will be seen that there is a decrease of 0°·7 of mean temperature for an increase of 1° of latitude.

The mean temperature of the dew-point for the whole of England is 43°·7; at all stations south of 52½° it was above the average, and at all places north of 52½° it was below, ranging from 45°·8 at Guernsey to 42°·1 at places between 54° and 55°.

The mean degree of humidity for the whole of England was 83; at Guernsey the degree of humidity was 85, and north of 54° it was only 81; between these two places the degree of humidity differed but little from the average.

The mean number of rainy days in England was 171; at Guernsey there was the least number of rainy days, viz. 162; whilst north of 54° there was the greatest number, viz. 184.

The mean annual fall of rain for England is 30·4 inches: at Guernsey 31·4 inches fell; between the latitudes 51° and 52° the fall was the smallest, viz. 25·7 inches; north of 54° the fall was the heaviest, viz. 35·7 inches.

LXIV. *New Mercurial Barometer and New Mercurial Maximum Thermometer.* By JAMES HICKS, Esq.

MR. HICKS submitted to the inspection of the Members of the Society a mercurial barometer and a mercurial maximum thermometer, possessing the novelties of construction that are given in the following description:—

BAROMETER.—Some time since I constructed an open-scale barometer, having a column of mercury in a glass tube, hermetically sealed at top, and perfectly open at bottom, the lower half of the tube being of larger bore than the upper.

If a column of mercury, of the exact length that the atmosphere at the time is able to support, be placed in a glass tube hermetically sealed at top, and of equal bore from end to end, the mercury will be held in suspension; but immediately the

atmospheric pressure increases, the mercury will rise towards the top of the tube, and remain there; on the pressure decreasing, it will fall towards the bottom, and any portion that the atmosphere is unable to support will drop out. But if the lower half of the tube be made a little larger in the bore than the upper, when the column falls, the upper portion passes out of the smaller part of the tube into the larger; and, owing to the greater capacity of the latter, the *lower* end of the column of mercury does not sink to the same extent as the *upper* end, so that the column becomes shorter. The fall continues until the column is reduced to the length which the atmosphere is capable of supporting; and the scale attached gives the reading of the barometer.

From this description it is evident that, by merely varying the proportions of the respective parts of the tube, a scale of any length can be obtained. For example, if the parts of the tube are very nearly the same in bore, the column has to pass through a great distance before the necessary compensation takes place; and we obtain a very long scale, say 10 inches for every 1-inch rise and fall in the ordinary barometer. But if the lower tube is made much larger than the upper, the compensation is quickly obtained; and we obtain a small scale, say from 2 to 3 inches for every inch. In order to ascertain how many inches in a barometer of this construction would correspond to an inch of the ordinary barometer, I attach it, together with a standard barometer, to an air-pump receiver; and by reducing the pressure in the air-pump I cause the standard barometer to fall, say 1 inch, when the other will fall, say 5 inches; and so I ascertain the scale for every inch, from 31 to 27 inches.

It was on this principle that I constructed the open-scale barometer (fig. 12), which has since been extensively used. But I found it impracticable to apply a vernier to barometers graduated in this way, because each varied in length in proportion as the bore of the tube varied, so that every inch was of a different length.

I have now remedied this defect, and made what I believe to be an absolute standard barometer, by graduating the scale from the centre, and reading it off with two verniers to the $\frac{1}{1000}$th of an inch (fig. 13). The scale is divided from the centre, up and down, into inches, and subdivided into 20ths.

To ascertain the height of a barometer graduated in this way, take a reading of the upper surface of the column of mercury with the vernier, then of the lower surface in the same way, and

the two readings added together will give the exact length of the column of mercury supported in the air, which is the reading of the barometer at the time.

There is another advantage in this manner of graduating over the former, that if a little of the mercury drops out it will give no error; as the column will immediately rise out of the larger tube into the smaller, and become the same length as before; but by the former scale the barometer would stand too high, until re-adjusted, which could only be effected by putting the same quantity of mercury in again.

I have introduced Gay-Lussac's pipette into the centre of the tube, to prevent the possibility of any air passing up into the top.

THERMOMETER.—In use, this thermometer (fig. 14) should be placed horizontally, and the mercury allowed to fall towards the bottom, until it fills the short tube at the side.

On an increase of temperature taking place, the mercury will rise in the small bore as in an ordinary thermometer.

But on a decrease of temperature, instead of receding in the small bore, as in an ordinary thermometer, it recedes from the short tube at the side, leaving the column of mercury in the small bore to register the maximum temperature attained.

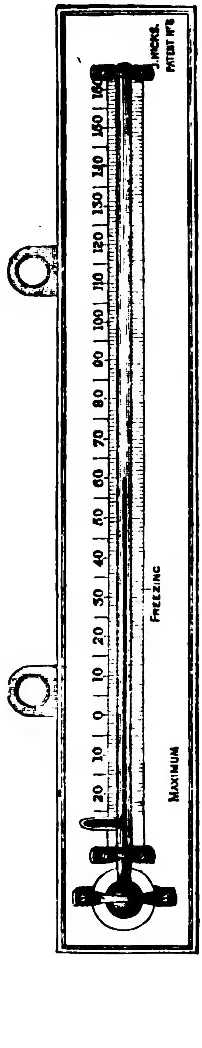
To reset the thermometer, lower the end nearest the bulb; the mercury will then fall till it fills the short tube at the side; then it will show the present temperature, and is set again for future observations.

The author thinks that this description of the thermometer in action, with the drawing, is sufficient to explain the principle on which it is constructed.

Fig. 12.

Fig. 13.

Fig. 14.



LXV. *Record of Rain at Cirencester, Gloucestershire, from* 1845 to 1863. By Thomas C. Brewin, Esq.

	1845.	1646.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.
January	1·90	4·65	2·77	1·22	1·92	2·01	4·05	5·70	4·10	2·98
February ...	1·00	1·40	2·40	4·05	1·75	2·03	0·85	1·70	1·05	0·96
March	1·30	1·87	1·80	3·20	0·90	0·91	4·60	0·50	1·00	0·63
April	1·90	3·65	1·58	3·50	3·10	4·33	1·13	0·70	2·56	0·25
May	2·50	2·21	2·30	0·45	3·35	3·50	1·45	2·00	3·40	2·90
June	3·60	1·10	2·90	4·90	1·72	1·09	2·63	6·82	3·80	1·73
July	2·80	2·15	1·43	3·08	1·20	5·31	1·74	3·15	3·96	3·16
August	2·97	4·45	0·92	2·90	0·93	1·80	2·90	5·67	3·72	0·90
September ...	3·15	1·45	2·60	4·42	3·80	2·70	0·50	5·48	1·87	0·70
October	1·50	6·25	5·83	5·05	2·44	1·47	2·67	3·88	4·23	2·72
November ...	3·00	1·70	2·54	1·64	1·70	3·17	0·64	8·95	2·20	1·52
December ...	3·30	1·00	3·85	3·63	3·10	2·85	1·65	4·30	1·00	1·48
	28·9	31·8	30·9	38·0	25·9	31·1	24·8	48·8	32·9	19·9

	1855.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	Average of 19 years.
January	0·43	3·35	3·03	0·60	1·50	4·52	1·45	2·70	3·30	2·74
February ...	1·25	2·10	1·55	1·00	2·11	1·20	2·75	0·35	0·72	1·60
March	2·64	1·58	1·95	0·90	2·42	2·27	2·90	4·70	1·25	1·95
April	0·60	3·33	2·60	5·25	2·70	1·00	0·65	2·22	1·23	2·22
May	2·08	3·95	1·76	2·65	1·25	3·85	1·15	3·95	1·40	2·42
June	2·58	1·27	2·92	3·18	2·78	5·92	2·65	2·97	5·32	3·15
July	4·85	1·30	2·47	2·00	1·65	1·75	3·94	2·00	0·50	2·55
August	2·05	4·20	1·30	1·97	2·48	5·03	0·90	2·25	3·65	2·70
September ...	2·27	3·95	1·80	2·94	3·40	3·35	3·16	3·87	3·00	2·86
October	5·60	3·35	3·57	1·76	2·95	2·00	1·74	4·72	3·75	3·44
November ...	0·45	1·10	1·25	0·83	2·77	3·00	4·10	0·55	2·10	2·27
December ...	1·30	2·92	0·84	2·56	2·95	3·05	1·80	2·10	1·73	2·40
	26·1	32·4	25·0	25·6	28·9	36·9	27·1	32·4	27·9	30·27

LXVI. *Notes on his Eighteenth Balloon Ascent.*

By JAMES GLAISHER, Esq., F.R.S., Secretary.

THE balloon left Woolwich Arsenal at $4^h 7^m$ P.M. on the 6th of April; at $4^h 10^m$ it reached the height of 1000 feet, and then ascended at an even rate of 1000 feet in 3 or 4 minutes, reaching the height of 11,000 feet at $4^h 38^m$. It then turned to descend at the rate of 500 feet per minute, and was 1500 feet high at $4^h 59^m$; was 1000 feet at $5^h 4^m$, and touched the ground at $5^h 18^m$.

During the whole day the sky had been very nearly overcast, with the wind from S.E. On leaving, we at once crossed the river Thames to Essex. At the height of 500 feet the air was very misty, and the view was limited to Woolwich, the Dockyard and Arsenal, a small portion of the river Thames, with numerous shipping, and a small portion of Essex. The mist increased as the balloon rose. At the height of 2000 feet we fell into a S.W. or W.S.W. current; at 2500 feet we entered a dense white cloud, and shortly afterwards lost sight of the earth. At the height of 3500 feet there was a thin, fine rain; above this the clouds were less dense, and there was a great increase of light; when at 4500 feet, we saw the sun faintly, but there was more cloud above. At 5100 feet high the sun cast a faint shadow; but we were still in cloud, and did not pass out of it till the height of 6500 feet was passed; mist was then prevalent, decreasing in density with increase of elevation. When at the height of 8100 feet there was a sensible pressure of the wind in our faces, and we were aware that the direction of the wind had changed, but we were quite unable to determine the direction from which it came; the mist increased till we reached 9000 feet; then decreased till, at the height of 9500 feet, the sun shone very brightly and it was quite warm. At 10,000 feet we were above all mist, and there was a sea of white cloud below us, dazzling in its brightness, extending, without a break or irregularity in its surface, as far as the eye could see; that is, for more than 100 miles on all sides. On the cloud was projected a bright oval halo of immense extent; in the centre of this the shadow of the balloon and car was situated, but without prismatic colours. This all revolved; for it was always on the side of the balloon away from the sun, and we knew we were turning round by the sun alternately shining on our backs and on our faces. At the greatest elevation reached, viz. 11,000 feet, there was profound repose, the sky of a beautiful deep blue and quite free from cloud.

When at the height of 9000 feet, we heard a train; and at the time concluded we were over the Chelmsford line of railway. From this height to that of 11,000 feet, we had been quite unable to determine in what direction we were moving; the grapnel had been lowered, and the line did not incline at all, but seemed to hang perpendicularly downwards.

Mr. Coxwell began to fear that the change of wind, that we had met with, might be carrying us out to sea; and it occurred to him that the railway we heard might be the Southend Railway; and if so, we were drifting out to sea. He therefore determined to take a dip below the clouds, without delay, so that, if we found ourselves over the sea, we might have gas enough to keep us up some time. We therefore began our downward journey: the sky continued of a deep blue, the air was free from mist, and the sun was hot till we approached the height of 7000 feet; and here we entered mist, and lost sight of the sun at 6000 feet high, and were in dense white cloud when 5000 feet from the earth; passed through a thin fine rain at 3000 feet, and caught sight of the earth at 2500 feet from it.

We expected to find ourselves over Essex; but well-wooded hills and a beautiful undulating country presented themselves, and we were at fault. It was necessary that we should determine our position, and we came down nearly to the earth, and, to our great surprise, found ourselves at Sevenoaks, in Kent, having recrossed the Thames. We had moved, then, diametrically opposite to the direction of the wind on starting, and with great velocity too; for on passing below the clouds we were moving as when we left the earth, so that, landing at Sevenoaks, we seemed to have come from the direction of the South Coast. It is impossible to say how far we had been into Sussex, or if we had been as far; but the Marquis of Camden, on whose estate we landed, said we were coming as from Hastings all the time he was watching the balloon.

The temperature of the air on starting was 45°·5; it decreased to 41°·7 at 1000 feet, to 37°·5 at 2000 feet, and to 32°, nearly, between the heights of 3500 feet and 4500 feet; it then changed to increase, and was 36° at 5000 feet; it fell again to 32°, nearly, at 6500 feet, but then increased to 40° at 7500 feet; it then decreased to 33° at 9000 feet, and increased to 36°·5 at the height of 11,000 feet. On descending, the temperature increased to 46° at 10,000 feet, remained without change for 3000 feet, then decreased gradually to 40° at 2000 feet, increased to 41°·7 at 1000 feet, and to 46° on the ground.

Whilst we remained at 11,000 feet high, the temperature increased from 36°·5 to 39°·0; at 10,000 to 3000 feet it was 7° to 8° higher than at the same height on ascending; at 1000 feet and at less heights the temperature was the same ascending and descending.

The temperature of the dew-point was 3° to 4° below that of the air at the time of starting: this difference continued almost unchanged to the height of 1500 feet; it then decreased, and at 3800 feet the fog was wetting, and the two temperatures were nearly alike; above 4000 feet they separated to the amount of 3° to 4°; at 7000 feet they were again near to each other; above this they separated to 12° at the height of 11,000 feet. On descending the air was much drier than on ascending: the temperature of the dew-point did not approach that of the air till the height of 2000 feet was reached. The distribution of the clouds, and the amount of vapour in the air, were much less over the county of Sussex and south part of Kent, than over the river Thames and the county of Essex near to it.

In a cubic foot of air on the ground there were 2¾ grains of water; in the cloud about 2 grains, and above the cloud about 1 grain.

The humidity of the air increased from the ground to the centre of the cloud, where it was all but saturated; and decreased rapidly above the clouds, where it was very dry.

No ozone was detected by Schönbein's, Moffat's, or Lowe's test-papers or powder, during the time the balloon was in the air.

The lines of the solar spectrum were very numerous and well defined; the spectrum itself was very long.

On Mr. Coxwell finding himself at Sevenoaks, and having been much nearer the south coast, he decided upon not reascending; for had he proceeded without taking the precautionary dip, we might, and probably should, have found ourselves over the Channel, without the power of keeping the balloon from the water; and he did not think it prudent to ascend again.

The results of this ascent are remarkable: they establish the prevalence of totally opposite currents of air within two miles of the earth; as also temperatures of the air, at heights exceeding a mile, actually higher than on the earth, at heights where usually it is more than 30° less.

LXVII. *Forecasts of the coming Season.* By Lieut.-Col. Henry Austen.

The author has studied the weather-type that has prevailed in the equinoctial periods, and hence infers the weather-period of the subsequent seasons.

LXVIII. *Forecasts of the coming Summer.* By T. Du Boulay, Esq.

Mr. Du Boulay addressed the Society in reference to the weather which, in his opinion, will prevail during the coming summer, his inference being deduced from the characteristics of the weather at the vernal equinox.

SUNDRY NOTES.

28. "*Causes which may bring about a Fall or a Rise in the Barometer**.—As heat produces rarefaction, a sudden rise of temperature in a distant quarter may affect the weight of the atmosphere over our heads, by producing an aërial current outwards, to supply the place of the lighter air, which has moved from its former position, in which case the barometer will fall. Now such a movement in the atmosphere is likely to bring about an intermixture of currents of air of different temperatures, and from this intermixture rain is likely to result.

"On the other hand, as cold produces condensation, any sudden fall of temperature causes the column of air over the locality to contract and sink to a lower level, whilst other air rushes in from above to supply the void, and, accordingly, the barometer rises. Should this air, as often happens, proceed from the north, it will contain in general but little moisture, and hence, on reaching a warmer latitude, will take up the vapour of the air, so that dry weather will result.

"It is generally observed that wind causes a fall in the instrument; and, indeed, in those greater movements of the atmosphere which we denominate storms or hurricanes, the depression is so considerable as to forewarn the navigator of his impending danger. It is evident that a draught of air in any direction must diminish

* *Vide* C. Daubeny, F.R.S., "On Climate."

the weight of the column overhead, and consequently cause the mercury in the barometer to sink.

"The connexion, therefore, of a sinking of the barometric column with rain is frequently owing to the wind causing an intermixture of the aërial currents, which, by their motion, diminish the weight of the atmosphere over our heads; whilst a steady rise in the column indicates the absence of any great atmospheric changes in the neighbourhood, and a general exemption from those causes which are apt to bring about a precipitation of vapour."—NEGRETTI AND ZAMBRA, *Treatise on Meteorological Instruments.*

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24. *Mr. Glaisher's Eleventh Balloon Ascent for Scientific Purposes, June 26th*, 1863.—The place of ascent on this occasion was Wolverhampton. The morning was fine, with very light airs and a clear blue sky, giving every promise of an easy ascent; but towards noon clouds gathered, some of a dark, threatening character, and the wind increased in strength. At one o'clock the sky was overcast with high clouds, and the wind was strong.

Five bags of sand were parted with at the last moment, to insure clearing adjacent buildings. This loss of weight caused the balloon to rise quickly, and its want was afterwards severely felt.

The earth was left at $1^h\ 3^m$ P.M.; at $1^h\ 7^m$ the height of 2000 feet was reached; at $1^h\ 15^m$, above 8000 feet; at $1^h\ 17^m$, 10,000 feet; at $1^h\ 26^m$, 15,000 feet; the balloon then rose gradually to about four miles and a quarter at $1^h\ 55^m$.

The descent was begun at $2^h\ 8^m$, when 20,000 feet from the earth; at $2^h\ 13^m$, above 15,000 feet; at $2^h\ 17^m$, 10,000 feet; at $2^h\ 22^m$, 5000 feet; and on the ground at $2^h\ 28^m$.

Before starting, the temperature of the air was 66°; it decreased rapidly on leaving the earth; was 54° at 3000 feet high; 49° at 4000 feet; 41° at one mile; 30° at two miles; and up to this time every succeeding reading was less than the preceding; but here the decrease was checked, and, while passing from two to three miles, the temperature at first increased to 32°, then decreased to 29°. A second increase followed; and at the height of three miles and a quarter the temperature was 35°. A rapid decrease then set in, and at three miles and a half the temperature was 22°. From this time, till the height of four miles was reached, the temperature varied frequently between 22° and 18°; and at the height of four miles and a quarter the lowest temperature took place, viz. 17°. On descending, the temperature increased to 26° at the height of 23,000 feet; and then to 32° at the height of four miles. It then decreased 9° in one minute, to 23°. It continued at this value for some time; then increased slowly to 29° at 19,000 feet, and continued almost constant for a space of 2000 feet; then increased to 32° at 15,000 feet, and was then 32° or 33°, almost without variation, during the snow-storm which we experienced from 13,500 feet to 10,000 feet high, when an increase set in. At 5000 feet the temperature was 41°, and 66° on the ground.

Some clouds were reached at $1^h 9^m$; at $1^h 16^m$ a very faint sun was seen; and it was expected, as usual, that its brilliancy would increase and that clear blue sky would be seen. At this time the sighing of the wind was heard—or rather moaning, as preceding a storm; and this continued some time, and is the first instance that either Mr. Coxwell or myself has heard such a sound at the height of two miles. It seemed to be caused from conflicting currents beneath the balloon. At $1^h 17^m$ some fine rain fell; at $1^h 17\frac{1}{4}^m$ a river could just be seen; a few seconds after, a cloud was entered. At $1^h 20^m$ again enveloped in dry fog; at $1^h 29^m$ there were faint gleams of light for a short time, and then all was closed up again. At $1^h 35^m$ the fog was wetting; at $1^h 37^m$ a dry fog was entered; at $1^h 40^m$ the sun was just visible, but for the most part cut off by the balloon. At $1^h 41^m$ again in fog, which continued more or less prevalent till $1^h 53^m$, when above four miles was reached.

At the highest point reached, above four and a half miles, the sky was very much covered with cirrus clouds; the sky, as seen between them, was of a very faint blue as seen from below through a moist atmosphere; we were above clouds. Owing to the thick and murky atmosphere, there were no fine views or forms, or anything picturesque, but all was confused and dirty-looking.

At $2^h 3^m$, on descending, even the faint sun was lost, and fog re-entered, and a decline of 9° of temperature in little more than a minute experienced. At $2^h 6^m$ there were faint gleams of light; fog both above and below, but not near us. At $2^h 7^m$ large drops of water fell from the balloon, covering my note-book; the next minute enveloped in fog, which became very thin at $2^h 14^m$. At $2^h 14^m$ rain fell, pattering on the balloon; this was shortly succeeded by snow, and for the space of nearly 4000 feet a snow-storm was being passed through; there were many spiculæ and cross spiculæ, with snow-crystals, small in size, but distinct; there were few, if any, flakes; as the balloon descended, the snow seemed to rise above it.

The state of the lower atmosphere was most remarkable; Mr. Coxwell had never seen it so murky before when far from a town; it was of a brownish-yellowish tinge, and remarkably dull. Herschell's actinometer was taken up: the sun shone on it once only at four miles high: the reading increased 9 divisions only in a minute; on the ground at 11^h A.M. it increased 33 divisions in a minute. The place of descent was about eight miles from Ely.

The readings from a new barometer for observations at high elevations only, were always coincident with those of a standard barometer.

Sounds were heard at a height exceeding four miles.—*Times*, 1863, July 2.

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25. ***Mr. Glaisher's Twelfth Balloon Ascent for Scientific Purposes, July* 12, 1863.**—The earth, from the grounds of the Crystal Palace, was left at $4^h 55^m$, the sky being covered with cirrus and cirro-stratus clouds, and the air in very gentle motion.

The balloon commenced moving to the W. till 4^h $59\frac{1}{2}^m$, when in a moment it came under the influence of a north wind and moved almost due south, the balloon being 2400 feet high. On descending, when at the height of about 2400 feet, an east wind was encountered, being the same height at which it was lost at 5 o'clock. The balloon travelled at the rate of about fifteen miles per hour, at elevations varying from 1000 to 2000 feet.

The temperature, at the time of leaving, at the Royal Observatory was $75\frac{1}{2}°$; at the Crystal Palace, 74°; in the balloon at 3600 feet high, at 5^h 4^m, it declined to 59°. A warm current was then entered, the temperature increasing to 61°·5, and decreasing to 60° at the height of 4300 feet. On descending to repeat these observations, it was found that all temperatures down to 3000 feet were nearly 5° higher than at the same height on ascending. At 6200 feet high, the temperature at 6^h 28^m was $52\frac{1}{2}°$; in half an hour the temperature fell from 1° to 2°. At 900 feet and 2000 feet, at 7^h 20^m, the temperature varied from 63° to 65°, and was $68\frac{1}{2}°$ on reaching the ground at Goodwood, at 8^h 50^m. The temperature at Greenwich at this time was 64°, and at Brighton 68°.

The currents of air on this occasion were remarkable; there was no transition state from one to the other: the stratum of air moving from the north must have been in contact with that from the east. After nearing Horsham, the north wind must have been compounded with some west. Frequently, when near the south coast, the smoke was moving in a different direction to the balloon; at Arundel it was moving in the opposite direction.

At the Royal Observatory, the horizontal movement of the air between the hours of 5 and 9 was at a rate less than two miles an hour; while during $3\frac{3}{4}$ hours the balloon had passed between sixty and seventy miles.

A similar result was shown last year in Mr. Coxwell's rapid journey from Winchester of seventy miles in sixty-five minutes, while the anemometer at Greenwich registered fourteen miles only.

The atmosphere was thick and misty; very distant objects were invisible; and the earth, not being lighted up by the sun at all, was dull. The fact of clouds reaching to four miles high, where the temperature of the dew-point must be some degrees below zero, as in the preceding ascent (implying the presence of very little water; yet there was enough in both cases not only to be visible, but to exclude everything beyond them)—this fact is important, and indicates that our theory of vapour must be reconsidered. The balloon descended at Goodwood Park.—*Times*, 1863, July 16.

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26. *Mr. Glaisher's Thirteenth Balloon Ascent for Scientific Purposes*, 1863, *July* 21.—The earth, from the Crystal Palace grounds, was left at 4^h 52^m P.M. In 10 seconds the balloon was in mist, and in 20 seconds on a level with the clouds, which were entered at the height of 1200 feet at 4^h 53^m. At 2200 feet thin rain was passed out of; and at the height of 2500 feet the surrounding clouds were very white, rendering it difficult to read those thermometers which had ivory scales. On passing through the lower

stratum of white clouds, another stratum of darker clouds, at a considerable height above the balloon, was observed. The clouds below were moving in a different direction to the balloon. At the height of 1100 feet, heavy rain was falling upon the earth, but none upon the balloon. At 2700 feet the balloon was in a dry fog; at 2600 feet in a wet fog; and, 600 feet lower down, very fine drops of rain were falling, and the clouds beneath were black. From the existence of the two strata of clouds, it would seem to be an established fact that whenever rain is falling from an overcast sky, there is a second stratum above.

The temperature of the air before leaving was 61½°; at 1000 feet high, 59°; at 2500 feet it decreased to 54°; at 2000 feet, 55°; at 1400 feet, 56°; at 700 feet, 51°; at 3000 feet, 52°; at 500 feet, 61½°; at 1800 feet, 57°; at 500 feet, again, 61½. The temperature of the dew-point was only half a degree below that of the air at starting; 2° lower on entering the cloud, which increased to 3° on rising above it. Rain-drops became smaller and smaller as the balloon ascended.

The direction of the wind on starting was S. by E.; at 2000 feet, S.W. At 2300 feet, the clouds moved with great velocity, in a different direction to that of the balloon; at 1800 feet the balloon seemed to be going backward.

The journey of twenty-five miles was performed in about 58 minutes. The horizontal movement of the air, during the same time, at Greenwich was about six miles.

The place of descent was five miles from Waltham Abbey.—*Daily Telegraph*, 1863, July 24.

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27. *Mr. Glaisher's Fourteenth Balloon Ascent for Scientific Purposes, August* 31, 1863.—This ascent was made from Newcastle. The earth was left at 6h 12m; in one minute the balloon was 350 feet high; at 6h 16m, 1800 feet; at 6h 17m, 2500 feet; at 6h 21m one mile, and ten minutes afterwards one and three-quarters mile was reached.

The temperature of the air on the ground was 64°; at 400 feet high, 56°. At the height of one mile the temperature was 40°. The lowest temperature obtained was 33½° at 6h 25m. On the earth, soon after the car touched the ground, at 7h 15m, the temperature was 53½°.

On the ground, before starting, the water in the air, in the invisible shape of vapour, was 5 grains in a cubic foot; at 1000 feet 4 grains; at 2500 feet, 3 grains; at 5000 feet, 2 grains; and 1¼ grain at the highest point.

The degree of humidity, considering air saturated as 100, was 77 on the ground; 87 in the thin cloud first met; decreased to 60 at the highest point; generally increased on descending to 100, or saturation, in cloud.

At 6h 29m 50s a rainbow was seen, extending from the cumuli clouds below to the upper clouds. At 6h 32m 30s a second rainbow was seen upon the clouds below.

Looking towards the E., the higher clouds were coloured brown;

the next layer bluish black; the third layer from the top was darker bluish black; the fourth thin layer, of white cumuli stratus; the fifth was greenish, resting on a bed of greyish-white, rocky cumuli forming the base of all.

Looking in opposite directions, there was a difference in the numerous tints.

At a different elevation the clouds were of a deep greenish blue, then, next below, a bluish black, then green, with greyish ill-defined clouds at base.

The descent was made at $7^h\ 5^m$, near Leamside Junction.

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28. *Mr. Glaisher's Fifteenth Balloon Ascent for Scientific Purposes, September* 28, 1863.—On leaving the earth at Wolverhampton, the sky was cloudy, with the wind S.W., varying to W.S.W. At the height of a mile, although no clouds had been passed through, a general layer of clouds was below, and clouds were very high above. On passing above two miles, two distinct layers of clouds could be seen below, and dense clouds still above.

Mist was seen rising vertically from the earth, and smoke from towns and villages, to the height of a mile, but with very little horizontal motion.

The balloon left at $7^h\ 43^m$; in two minutes it was 500 feet above the earth, 1000 feet at $7^h\ 47^m$, 2000 feet at $7^h\ 52^m$, two miles at $8^h\ 30^m$, about two and a half miles from $8^h\ 45^m$ to $9^h\ 8^m$, near two and three-quarters miles from $9^h\ 15^m$ to $9^h\ 23^m$, and the highest point, three and a half miles, at $9^h\ 33^m$.

The ground was reached at Temple Briren, six miles from Sleaford, at $10^h\ 30^m$.

The temperature of the air on the ground had increased from 43° at 7^h to 48° at $7^h\ 43^m$, when the balloon left; it then declined, being 45° at 100 feet, 40° at 300 feet, 34° at one mile, 27° at one and a half mile, 21° at two miles. A quick decline then took place, the thermometer reading 12° at two and a half miles, at which height the temperature, during 15 minutes, varied from 17½° to 14°, and then suddenly decreased 3° in two minutes, which was sensibly felt. On passing above two and a half miles, the temperature varied from 16° to just about 0°.

On descending, the temperature varied from 7° to 15° at two miles and three-quarters, between $9^h\ 36^m$ and $9^h\ 52^m$; it was 35° at one mile, 40° at 3000 feet, 50° at about 1000 feet, and 58° on the ground.

The temperature of the dew-point on the ground was 44°; at 2000 feet high, 35°; at one mile, 25°; at two miles and a half, varying between 20° and 12°, being at times the same as the temperature of the air. Above this level the dew-point decreased to 10° below zero; the air was not saturated, but approached more nearly to that state than is usually the case at such an elevation. On reaching the ground, the temperature was 46°.

There was no opportunity of reading Herschell's actinometer in the balloon till $9^h\ 4^m$, when the increase in one minute with a bright sun was five divisions. This result was obtained again at

$9^h\ 8^m$. The increase was seven or eight divisions occasionally, between $9^h\ 29^m$ and $9^h\ 49^m$. At $10^h\ 7^m$ it was twenty divisions in a minute; at $10^h\ 19^m$, twenty-five divisions; and on the ground, at $10^h\ 45^m$, forty-eight divisions.

On this occasion a blackened-bulb thermometer, as delicate as the shaded thermometers, was used, and so placed as to be full in the rays of the sun. The readings of the two thermometers were identical till $9^h\ 48^m$, when faint gleams of the sun caused the black-bulb to read 4° above that of the air; on leaving these, it fell to that of the air. Faint gleams falling on it occasionally caused an increase of 2° or 3°. On reaching the height of three miles and above, the sun shone brightly; the blackened-bulb thermometer read from 2° to 4° only in excess of the shaded thermometer. On reaching the ground this excess had increased to 30°.

Ozone-papers, by Mr. Lowe, of different preparations, were abundantly spread about the rigging, and were not coloured at all throughout the journey. Ozone-powders, by Mr. Lowe, made of wheat-starch and iodide of potassium, mixed three months ago, were slightly tinged when first exposed, and were unchanged at the height of one mile; they then increased in colour, and continued to increase till noticed at $9^h\ 57^m$, when they were as dark as four on a scale of ten.

The descent on this occasion was a very rough one, owing to the high wind.

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29. *Mr. Glaisher's Sixteenth Balloon Ascent for Scientific Purposes, October* 9, 1863.—The earth was left, from the Crystal Palace Gardens, at $4^h\ 29^m$; in 4 minutes 2500 feet was reached; at $4^h\ 38^m$ the height was 5400 feet; at $4^h\ 43^m$, 7100 feet, London Bridge being directly under the balloon. At 6^h the height of 8600 feet was reached, and a higher point afterwards, but it was too dark to read the instruments. The ground was reached at $6^h\ 40^m$.

At starting, the temperature was 54½°; at 5600 feet, at freezing; at 7200 feet, 29½°; 44½° at 1600 feet, and 26° at 8600 feet.

The air was moderately dry at starting, and generally continued so; but at times spaces were passed through which were very moist, but without visible vapour.

The healths of our Queen, the Emperor of Austria, and the President of the United States, were drunk at the height of 7000 feet. At this height the whole of London was distinctly seen. The Bank, Newgate, and other large buildings directly under the balloon, were seen in such detail that their ground-plans might have been drawn.

The whole of the scene was surmounted by a canopy of blue, the sky being quite clear and free from cloud everywhere, excepting near the horizon, where a circular band of cumuli and stratus clouds, extending all round, formed a fitting boundary for such a scene.

The descent was at Pinton Grange, on the borders of Hertfordshire and Bedfordshire.

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

VOL. II. 1864, JUNE 15. [No. 14.

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Thomas Pollock, Esq., 129 Fenchurch Street, E.C.;

Rev. Thomas Arthur Preston, M.A., Assistant-Master of Marlborough College, Wilts;

Dr. W. T. Radford, Sidmount, Sidmouth, Devon, and Athenæum Club, Pall Mall, S.W.;

Samuel Smiles, Esq., West Bank, Blackheath, S.E.;

John Pike Stephens, Esq., Bridport, Dorset;

were balloted for and duly elected Members of the Society.

The following gentleman, who had been duly elected a Member, subscribed the Form No. 2, and was admitted into the Society:—

	Elected
Alexander Beattie, Esq.	1864, March 16.

LXIX. *Explanation of Meteorological Tables illustrating the Climate of East Tropical Africa.* By JOHN KIRK, Esq., M.D. (of Dr. LIVINGSTONE's Zambesi Expedition). Received June 1864. Communicated by F. GALTON, Esq., F.R.S., Foreign Secretary.

I SEND a few meteorological Tables, to show you the sort of climate we have been in. So far as they go, I have confidence in them. The instruments were excellent and carefully rated. The present Tables would bear much extension. They were compiled in the bush for a particular purpose, and I have not again gone over my journals to fill up the blanks. In all cases the index errors have been allowed.

The barometric observations were made with great care. In such parts barometers are extremely awkward instruments; but the boiling-point is very rough, and for the gradient of a river almost useless. In the abnormal states of the air, with unknown lower stations, I felt sure that with different forms of instrument errors of 500 feet may be accumulated.

In working up the results many formulæ have been compared; but none equal for extreme accuracy the Tables of Boileau. More elaborate calculations, I feel sure, often give worse results.

For tension, dew-point, and humidity the Cape Observatory tables have been employed, being very accurate. The risk is diminished of error from working out in detail the full formulæ; but I question whether we have the elements for some of the abnormal states of air met with; and possibly other disturbing causes should be allowed for, which are not needed at the ordinary condition.

Besides the absolute height of Nyassa, I have the heights of each of the main rapids along the line of descent.

TABLE I. The observations here reduced were made at Tete, on the Zambesi, distant 250 miles from its mouth, and from 200 to 300 feet above the sea-level.

No continuous coast-range shuts it out; but several hills, such as those of Lupata, from 400 to 600 feet high, lie scattered in the intervening space.

Being our dépôt for spare goods at rain-times, I spent from two to three weeks at Tete, and made careful series of observations, which have been employed to check those made under our guidance by two intelligent Portuguese officers, with expedition-instruments to which, as in other cases, have been applied the necessary index-errors. At the same time that I was satisfied of the accuracy of the thermometric observations, I was lead to reject the barometric from errors of reading which seemed to vitiate them in many places.

In this Table each month is fully represented by daily observations, chiefly in 1859.

The first column shows the rain-fall, and, with the foot-note, contains all the accurate matter in my possession on this subject. The gauge was placed at 1½ foot above the ground. Under these circumstances, at Tete the amount varies from 33·56 inches to 47·23 inches in ordinary seasons.

The first showers fall in October, but hardly affect the rivers, which show the first rise in the *first week of November*: this is due to local rains, and frequently is of temporary duration, the steady rise of level not taking place until *December*.

The rains of November are heavy, accompanied with thunder, but do not, like those of January or later in the season, last long. In February or March the highest level has been reached by the rising, and from that time they commence to subside. The absolute height of the river depends on the amount of obstruction to its free escape below: thus a rise at Kebrabaisa of 80 feet occurs where limited to a narrow gorge between high perpendicular rocky cliffs; at the same time at Tete the river will not exceed its low-

water level more than 20 feet, and will be much under that below Lupata, where it flows in a wide channel five miles from bank to bank, with a level country over which to expand, and no barrier to obstruct its progress to the sea. (See Table VI. B.)

In May a few showers fall, but are hardly appreciable in the gauge. In June, at Tete, there are the "showers of the wheat," on which the success of that crop much depends; these are unknown in the interior, but are continued, as in August, in some parts of the coast-range of mountains.

July, August, and September are absolutely rainless months, generally speaking.

Columns 2 and 3 show mean maxima and minima observations. The latter, from the instrument being badly placed, perhaps hardly gives a low enough temperature, although, on checking these with other observations made at sunrise, very little difference is observable, and Tete, being surrounded by and built on bare rocks, is an exceptional locality.

Columns 3 and 4 show the highest and lowest temperature of each month, and No. 14 the difference in range during the month.

Columns 6, 7, 8, 9 are wet- and dry-bulb observations made at 9 A.M., with deduction relating to the hygrometric state of the air from them, and, with a similar series in Columns 10, 11, 12, and 13, give the fullest view of the climate in any of the series of Tables.

While the greatest heat of the year is reached in November, the greatest monthly mean is attained not until January, and the greatest humidity in April, just as the rains, which have soaked into the ground, begin to abate, and the temperature to diminish, lessening the capacity for moisture.

The coolest month is July, while the mean annual heat or isotherm of Tete seems to be 80°—a little in excess of other parts, the mean isotherm of the Lower Zambesi being probably between 78° and 79°.

TABLE II. These are collected observations made at various times when in the Zambesi delta. In comparison with other parts, the amount of moisture is greater, dew being deposited at all seasons.

TABLE III. In different years, while passing up and down the Shiré, observations were accumulated, which have been thrown together in this Table. The Shiré valley is open to the S., but backed by a mountain-mass in the N., which, when the sun has a northern declination, serves to cut off much of the heat. Accordingly we find that then the temperatures, and especially the early ones, are below the average of other parts, while the hot season equals

that of Tete; although with lagoons and swamps, the amount of moisture is not great, from the mountain being in part between it and the sea.

TABLE IV. gives the results of observations while stationed on an island in the Zambesi delta during July 1858. Passing, for the present, over the barometer-column, Column 2 exhibits the diurnal variations of the thermometer at different hours of the day. Part of these results are included in Table II.

The temperature of the soil of the island, at 2 feet deep, was 70°·5.

TABLE V. The Rovuma, a river entering in lat. 10° S. from the W., was twice visited—first, during the rain, when in flood: it was then ascended 40 miles; and the upper Table represents the observations then made. During a boat-expedition in the dry season, when we ascended 115 miles, the second Table was obtained. In these Tables no great difference is observed between the country in lat. 10° S. and that in lat. 18°, both heat and moisture being nearly equal, while the sequence of rainy and dry seasons is the same.

TABLE VI. A register of the temperature of the water of the Zambesi and Shiré, observed in the deep channel, was kept when practicable, being entered twice daily, at sunrise and at 3 P.M., thus giving the maximum and minimum. This Table is the mean of these, during flood, when the mass of water is great: the daily variation was 2°, and at other times 3°. In days of excessive heat these were exceeded, but not to any great amount, while in dull days the variation was almost nothing. These are almost identical with the monthly means.

TABLE VII. A month was spent at Sesheke, a Makololo town on the Zambesi, above the Victoria Falls. Advantage was then taken to ascertain the barometric and thermometric states of the air in the inland region, and considerable pains taken to obtain accurate results. Unwilling to sacrifice a few thermometric observations which wanted the corresponding hygrometric readings, a separate Table was made, from which the chief dew-points and humidities have been taken. The number of single observations was so small, however, that the results would hardly have been appreciably affected even had this precaution been neglected.

The diminished humidity is the most remarkable point shown by this Table: while at Tete we have a humidity of 62 and 45, here we find only 33 and 22.

TABLE VIII. shows the changes observed on the Batoka Plains,

which were crossed when on the way to Sesheke, and compared with Table X., from observations which were made on the return, while following a route not far off, although a little further S., and nearer the Zambesi, in a more unequal country.

TABLE IX. indicates the greatest cold experienced by us in Africa. Although the heights were only 3800 feet above the sea, a temperature of 25° was once noticed, ice was seen, and hoar frost; while during the day the air did not become oppressively hot, and the air at the same time was clear and dry.

TABLE X. shows a contrast to Table VIII., although in a region not many miles distant, but at a different season. The differences between the wet and dry bulbs would cause me to doubt whether the common formulæ hold good under these unusual conditions. On one occasion there was a difference of 40°, with a dew-point of 38°·2, and in twenty-four hours the temperature changed from 101° to 55°. The surface of the soil was heated to 137° when exposed to the sun. Excessive change and extreme dryness seemed the prominent features of this region at this time of year preceding the rains.

TABLE XI. Observations made while descending the Zambesi from Sinamane, where free canoe-navigation commences after the Victoria Falls to where it is again obstructed by the rapids of Kebrabaisa, it being *possible* to force all the intermediate ones.

TABLE XII. *Barometric Heights.*—As a preliminary to obtaining barometric heights of various parts visited, observations were made, first, at an island in the delta, where I was stationary for a month, and again during a similar period in the centre of the African continent, to ascertain the diurnal normal barometric wave and the limits within which these undulations took place.

These have been projected, in Table XII., in a diagram (fig. 12), in which the continuous line shows the coast-undulations, and the dotted line the daily waves as seen in the central region. They are taken from Tables IV. and VII., where the accurate heights are cleared of all errors except those of height above the sea, which in the observations made in the delta will be very small. While at both places the double daily wave is visible in the coast-region, it is much larger than in the interior. These Tables have been used, in the reduction for the determination of heights, to bring observations made once daily to correspond with those at the upper station made at different hours. In the tropics, where the barometric wave follows with great regularity, this may with great advantage be done, and errors of 100 feet eliminated.

TABLE I. Observations at Tete, lat. 16° 9′·8 S., long. 33° 30′ E. of Greenwich.

	Rain in inches.	Means.		Extremes.		9 A.M.				3 P.M.				Range.	Mean temperature.
		Minimum.	Maximum.	Lowest.	Highest.	Dry-bulb.	Wet-bulb.	Dew-point.	Humidity.	Dry-bulb.	Wet-bulb.	Dew-point.	Humidity.		
		°	°	°	°	°	°	°		°	°	°		°	°
January	7·81	76·7	......	70·	89·	85·	76·5	71·	62	88·2	78·	71·5	57	19	85?
February	3·86	77·8	88·1	75·	91·	82·	77·3	74·1	77	86·4	78·5	73·4	64	16	83
March	7·79	76·7	87·9	73·	91·	80·6	76·6	73·9	80	86·5	78·5	72·4	64	18	82
April	1·27	76·1	86·7	71·	95·	78·7	76·	74·1	86	84·8	78·7	74·7	72	24	81
May	0·5	71·6	85·4	69·	88·5	76·2	69·2	64·2	67	84·	71·7	63·6	50	20	79
June	0·5	69·3	80·2	65·5	84·5	72·7	66·2	61·4	68	78·9	67·8	61·8	53	19	75
July	0·	68·2	77·4	65·	82·5	70·3	63·5	58·3	66	76·4	65·5	57·8	52	18	73
August	0·	69·8	81·6	66·5	88·5	73·	65·4	59·8	64	80·9	68·1	58·1	48	22	76
September	0·	74·9	87·8	65·	82·5	80·	71·2	65·2	60	87·6	72·6	63·	43	18	81
October	0·	76·5	90·1	72·5	97·	83·4	73·7	67·2	58	89·5	74·6	65·2	43	25	83
November	4·52	77·6	91·2	73·	100·	83·8	76·6	71·8	67	88·1	77·7	71·	57	27	84
December	7·31	77·3	90·4	73·5	99·	84·1	77·	72·3	68	88·7	77·9	71·	56	26	84
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Total rain-fall in 1859–60=33·56 in.; in 1860–61=47·23 in.

Mean temperature of the year=80°.

Note.—Observations made in the town of Tete, at heights from 40 to 60 feet above the mean river-level, chiefly in the year 1859.

TABLE II. Mean Results of Observations during various years in the delta of the Zambesi.

	6 A.M.		9 A.M.		Noon.	3 P.M.		6 P.M.	
	Dry-bulb.	Wet-bulb.	Dry-bulb.	Wet-bulb.		Dry-bulb.	Wet-bulb.	Dry-bulb.	Wet-bulb.
	°	°	°	°	°	°	°	°	°
March	72·4	71·7							
April	68·								
May	68·	......	71·8	......	78·	78·3	......	73·5	
June	61·4	......	65·9	63·	76·6	78·2	68·2	69·	65·
July	59·6	59·3	69·6	66·2	......	75·8	67·2		
August	63·7	......	70·8	......	......	79·5	72·8		
December ...	76·9	75·6							
	Dew-point.	Humidity.	Dew-point.	Humidity.		Dew-point.	Humidity.	Dew-point.	Humidity.
	°		°			°		°	
March	71·2	96							
May									
June	......	......	60·7	83		61·3	56	67·9	78
July	59·	98	63·6	81		60·9	61		
August	......	......	......	......		68·2	68		
December ...	74·7	93							

TABLE III. Observations made on board ship in the river Shiré, between lat. 16° to 17° 40′ S., and long. 35° E. of Gr.

	6 A.M.		9 A.M.		Noon.	3 P.M.		6 P.M.	
	Dry-bulb.	Wet-bulb.	Dry-bulb.	Wet-bulb.		Dry-bulb.	Wet-bulb.	Dry-bulb.	Wet-bulb.
	°	°	°	°	°	°	°	°	°
January......	76·4	74·1	80·5	76·7	87·1	87·3	78·6	83·7	78·2
February ...	73·3	......	77·6	73·2	87·3	85·9	75·6	80·9	
March	75·3	73·8	80·1	76·1	88·6	88·4	77·1	85·	78·6
April	72·3	70·6	79·8	74·9	87·1	86·2	76·4	81·9	76·4
May	62·2								
June	60·4								
July	54·7								
August	56·4								
September ...	63·4								
October	72·2	......	......	......	96·9				
November ...	73·5								
	Dew-point.	Humidity.	Dew-point.	Humidity.		Dew-point.	Humidity.		
	°		°			°			
January......	72·5	87	73·1	81		76·3	62		
February ...	......	......	70·1	77		68·9	57		
March	72·7	91	73·3	78		69·9	54		
April	69·3	90	71·6	77		70·	59		

TABLE IV. Observations in the Zambesi delta, on an island 20 feet above water-level, lat. 18° 24′ S.; long. about 35° 30″ E. of Gr.

July 1858.

Hour.	Barometer corrected for index error and radiation to 32°.	Thermometer (dry-bulb).	Thermometer (wet-bulb).	Dew-point.	Humidity.	Tension.	Number of Observations.
	inches.	°	°	°			
A.M. 4	30·189	61·5	60·9	60·4	96	·526	5
6	30·200	59·6	59·3	59·	98	·500	9
8	30·229	64·8	62·5	60·6	86	·529	19
9	30·234	69·6	66·2	63·6	81	·588	21
10	30·282	70·6	66·7	63·7	78	·590	13
Noon.	30·227	......	......	......	......	......	27
P.M. 2	30·182	......	......	......	......	......	12
3	30·189	75·8	67·2	60·9	61	·535	22
4	30·159	......	......	......	......	......	9
6	30·198	......	......	......	......	......	17
8	30·216	......	......	......	......	......	28
10	30·218	......	......	......	......	......	15
Midnight	30·194	60·2	60·1	60·	99	·518	2

Night-radiation by nine observations 55°, or radiation =5°.
Mean temperature of soil at 2 feet deep =70°·5

TABLE V. On board ship, river Rovuma, lat. 10° S., coast-region. 26th February to 19th March, 1861.

Hour.	Dry-bulb.	Wet-bulb.	Dew-point.	Humidity.	Tension.	Number of Observations.
	°	°	°			
A.M. 6	78·3	76·2	74·7	88	·860	15
9	83·6	78·9	75·7	77	·888	11
Noon.	85·6	78·4	73·7	67	·832	14
P.M. 3	85·9	78·5	73·7	66	·832	11

River in high flood. Sky commonly clouded; heavy dews and frequent rains.

Made on board of the boat, river Rovuma, lat. 10° S., between the coast and the rapids, 115 miles distant in direct line. 9th September to 10th October, 1862.

Hour.	Dry-bulb.	Dew-point.	Humidity.	Number of Observations.
A.M. 6	69°·	68°·3	93	21
9	77·6	68·1	66	7
Noon.	84·7	69·1	56	6
P.M. 3	86·1	63·6	42	10
6	80·7	...	...	9

The first shower of the season fell on 4th October. There were heavy dews every morning, about 4 A.M. Sky clear, cloudless. East wind blowing almost daily.

TABLE VI. A. Water Temperatures of Zambesi and Shiré below the last Rapids, in the deep channel, being the Mean of a Maximum and Minimum Observation made daily.

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
82°·5	84°·6	83°·5	78°·5	75°·5	72°·0	70°·3	71°·8	76°·0	80°·9	° ...	84°·6

The mean diurnal variation, when the rivers are in flood, is 2°; when low, 3°.

B. Periodic Rise of the River, and its height, at Tete, above low water.

				ft.	in.
1859.	November 4 ...	River	rising at Tete.		
1860.	March 12	„	at its highest level =	18	5
	November 8 ...	„	rising at Tete.		
1861.	February 2 ...	„	at its highest level =	21	0
	November 2 ...	„	rising in the Shiré.		
1862.	March	„	at its highest level =	19	0

TABLE VII. Obervations at Sesheke, Central Africa, lat. 17° S.; long. 24° E. 16th August to 17th September, 1860.

Hour.	Barometer (Aneroid) corrected for index-error.	Thermometer (dry-bulb).	Tension.	Dew-point.	Humidity.	Number of Observations.
	inches.	°		°		
A.M. 1	27·09	59·0	......	......	......	4
3	27·00	59·5	......	......	......	3
5	27·03	51·2	......	......	......	1
6	27·06	52·4	·225	37·6	55	29
7	27·10	53·9	......	......	......	20
8	27·11	63·5	......	......	......	19
9	27·14	70·6	·252	40·5	33	29
10	27·17	74·0	......	......	......	13
Noon.	27·10	83·8	......	......	......	14
P.M. 1	27·09	85·2	......	......	......	20
2	27·05	83·8	......	......	......	16
3	27·04	87·1	·299	45·0	22	29
4	27·03	85·6	......	......	......	23
5	27·03	82·9	......	......	......	16
6	27·04	75·7	......	......	......	17
7	27·03	72·1	......	......	......	8
8	27·04	68·1	......	......	......	12
9	27·09	70·9	·431	54·9	42	5
10	27·03	59·9	......	......	......	2
11	27·02	65·2	......	......	......	2

TABLE VIII. Observations while crossing the Batoka Country, lat. 17° 30′ S.; long. 26°–27° E. of Gr. Altitude above sea-level from 3000–3800 feet. 27th July to 6th August, 1860.

Hour.	Dry-bulb.	Wet-bulb.	Difference.	Dew-point.	Humidity.	Number of Observations.
A.M. 6	44·2	38·1	6·1	30·9	59	9
9	65·4	51·1	14·3	39·4	39	7
Noon.	72·2	......	......	......	......	6
P.M. 3	73·3	52·4	20·9	36·9	27	7
6	64·0	51·8	12·2	45·3	44	5

Lowest temperature observed at camp was .... 32°
" " " in bed of streamlet 25
Highest temperature observed at camp .... 77·8
Extreme range .... 52·8
Mean range .... 19·8
Thermometer shaded.............. 87°·5 } Radiation = 3°·5
" exposed to the sky 84°· }

TABLE IX. Observations while descending the Zambesi, from Sinamane to Kebrabarsa, lat. 16°–17° S.; long. 27° to 31° E. of Gr.

7th October to 2nd November, 1860. Barom. 28·6 in. to 29·4 in.

Hour.	Dry-bulb.	Wet-bulb.	Difference.	Dew-point.	Humidity.	Number of Observations.
A.M. 6	76°·7	68°·3	8°·4	62°·4	61	5
9	84·4	71·0	13·4	62·1	47	5
Noon.	92·8	72·8	20·0	60·6	34	4
P.M. 3	91·3	72·8	18·5	61·3	38	5

Hour.	Dry-bulb.	Number of Observations.	
A.M. 6	72°·5	28	Mean of more extended observations of air-temperature.
9	84·5	16	
P.M. 3	93·6	20	

Hour.	Water.	Number of Observations	
A.M. 6	79°·2	19	Temperature of water of Zambesi = 81°·4
P.M. 3	83·5	17	

TABLE X. Observations corresponding with above, made during march up the Zambesi Valley, from 26th June to 24th July, 1860.

Hour.	Water.	Number of Observations.
A.M. 6	49°·8	27
P.M. 3	78·3	6

Maximum .... 80° | Minimum .... 40°

TABLE XI. Observations between the Victoria Falls and Sinamane, crossing the Batoka Hills, not far from the Zambesi. Barom. 29·9 in. to 26·4 in.

23rd September to 7th October, 1860.

Hour.	Dry-bulb.	Wet-bulb.	Difference.	Dew-point.	Humidity.	Number of Observations.
	°	°	°	°		
A.M. 6	65·3	......	......	......	...	8
9	79·8	58·0	21·8	43·2	27	1
Noon.	93·0	63·8	29·2	55·0	28	2
P.M. 3	94·8	61·2	33·6	41·0	15	6
On 1st October.						
P.M. 3	101·0	61·0	40·0	38·2	11	

The following morning, air in shade .... 55°

Minimum observations... 55° } Extreme range.. 48
Maximum observations... 103° }

6th October, thermometer placed under the soil exposed to the sun .... } 187

TABLE XII. Projection of Diurnal Barometric Waves observed at the Sea-coast, Zambesi Delta, and at Sesheke, in the centre of the Continent, above Victoria Falls.—Dr. KIRK.

Fig. 12.

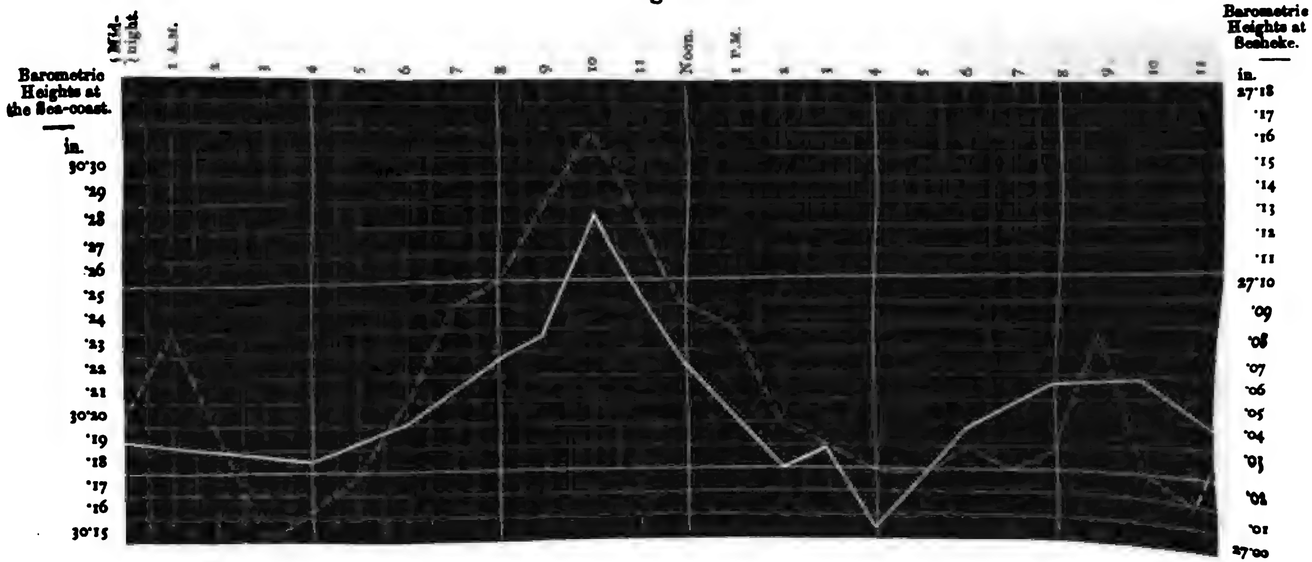
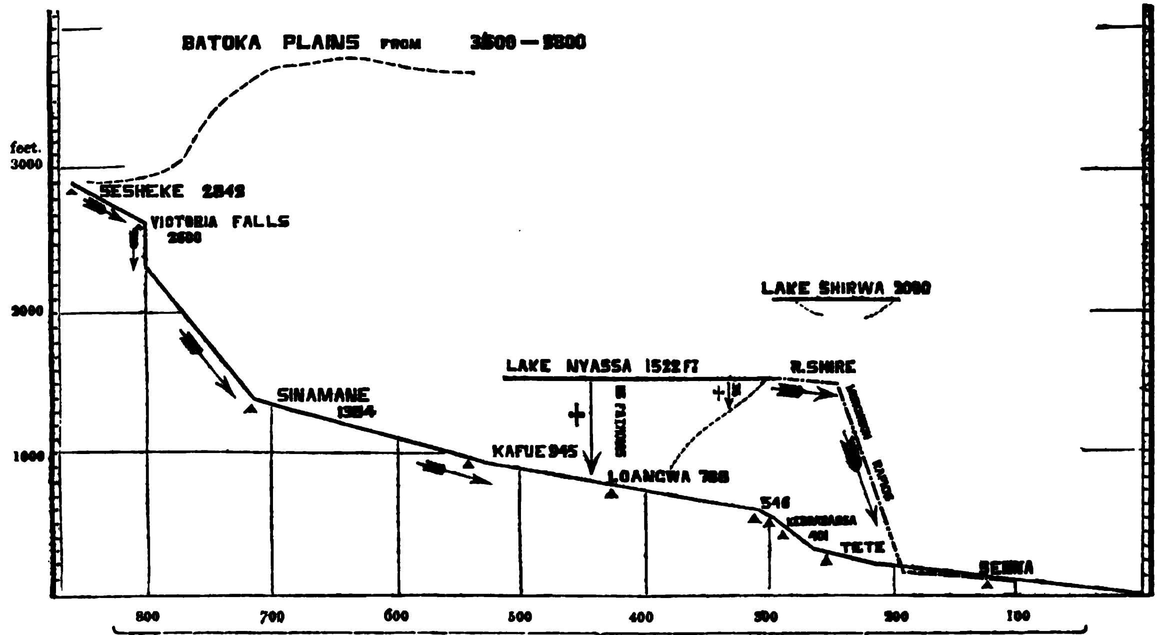


TABLE XIII. Gradient of the bed of the Zambesi, from Barometric Measurements, by Dr. Kirk, in 1860; and of the Nyassa Lake and River Shiré, from two double series of Barometric and Boiling-point Observations, 1859 to 1861.

Fig. 13.



LXX. *Ozone Observations at Helsingfors, Finland.* By E. H. Julin. Communicated by L. P. Casella, Esq.

(Extract from a Letter.)

The papers I took the liberty of sending, and which you flattered me by putting before the Meeting of the British Meteorological Society*, were all taken in Helsingfors this last winter, outside a window at the corner of a street leading from the open harbour. It was not quite known to me whether the thermometer was a correct one. My instruments being in the country, I could not give barometrical, &c., observations, except when by chance I saw such at a friend's. The observations that I took last year, in September, in Aix-la-Chapelle, of which I forwarded to you a sample, did not show any ozone. One thing allow me to correct. You believe that the papers had not, after their exposure to the air, been dipped into distilled water. But I had done it, both here as well as in Aix-la-Chapelle. The next sheet following yours, already received, I enclose; the papers of which have all been dipped into distilled water after their exposure. The next sheets of observation I shall take with me to show you in London, in case I go there this summer.

I draw the conclusion from the few winter months' observations that I have taken, that during the northern winter, as soon as the temperature begins to get warmer, or rather before the thermometer indicates the rise, the ozone increases, and increases with the thaw. But, as soon as the thaw finishes, the ozone does so also; yet it is not so soon put out of existence as one might suspect from its arrival with the warmer atmosphere. The cold air has no appreciable ozone, except what either lingers from the past warmth or forebodes with the barometer the coming thaw.

LXXI. *Photographic Reproductions of Magnetic Tracings at Kew and Lisbon.* By Balfour Stewart, Esq., M.A., F.R.S.

Mr. B. Stewart exhibited to the Society specimens of photolithographic impressions of the traces simultaneously produced by the magnetographs at Kew and Lisbon, and made a few remarks on some of the peculiarities which these present.

When the publication of these is complete, a set will be presented to the Society.

* *Vide* Proc. Brit. Meteor. Soc. vol. ii. No. 11. p. 107.

ANNUAL GENERAL MEETING.

1864, June 15.

The business of the Ordinary Meeting having terminated, the Annual General Meeting was held, and the following Report of the Council was read.

REPORT.

The following extracts are taken from the Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, read at the Annual Visitation of the Royal Observatory, 1864, June 4:—

Royal Observatory.—"An important alteration has been made in the Magnetic Observatory. For several years past, various plans have been under consideration for preventing large changes of temperature in the room which contains the magnetic instruments. At length I determined to excavate a subterraneous room or cellar under the original room. The work was begun in the last week of January, and in all important points it is now finished. The ground was cut down on all sides in the plane of the inner surface of the former walls, and within this space a 9-inch wall was built all round, so that the transverse dimensions of the room are less by 18 inches than those of the former room. Bricks were selected which were almost free from magnetism. The room is illuminated, when necessary, by three well-windows, facing the south; these can be covered by yellow glass or by wooden shutters, and can otherwise be blocked. It can be warmed by a gas-stove, and lighted by gas-lights. Ventilation is provided by a large copper pipe leading to the ventilating-cowl of the upper room (no longer required for the upper room), through which pipe the warm stove-pipe is led nearly to the top. Drainage is effected by a pump in the ground outside of the building, about 20 feet distant from the eastern arm of the building. The building has been somewhat delayed by the illness of the Superintendent of Works, and also by the circumstance that the walls dry slowly. The reading of the atmospheric dew-point, at this season, is sometimes higher than the mean temperature of the ground, which is the temperature of the walls. It seems probable that the stove will be required more frequently in summer than in winter. On the erections for carrying the instruments I shall speak hereafter.

"In taking the observations with the altazimuth, the reading of the barometer has been corrected for the small error which was found to exist in it, and the thermometer has been read more frequently and at smaller intervals from the observations.

"The earthquake of 1863, October 5, $15^h\ 23^m$, was seen with the altazimuth telescope by Mr. Ellis, who happened to be observing the collimator. The mark appeared to descend, to rise rather more, and to descend a little to its original position.

"*Magnetical and Meteorological Instruments.*—I have stated

above, that the excavation for the new Magnetic Basement was begun on January 25 of the present year. It is unnecessary to say that the observations of declination, horizontal force, and vertical force were at once suspended; and my remarks on the operation of the instruments apply only as far as January 25. All have been in excellent order. The vertical-force magnetometer still exhibits sometimes the 'dislocations' in the photographic trace. There is no evidence, I believe, that these dislocations do not exist in the curves of every vertical-force instrument, for they are always accompanied with vibration; and no vertical-force instrument, I believe, except that of Greenwich, gives a trace strong enough to exhibit vibrations; and the dislocations, therefore, with any other instrument would appear merely as interruptions of the trace, and would not attract much attention.

"In the preparations for mounting the instruments in their new location, the following points are worthy of remark:—

"The declination-magnet in the Magnetic Basement (a new 2-feet magnet by Mr. Simms) is carried by a pier built of brick and slate, whose upper part or suspension-piece protrudes through the floor of the upper room, for the sake of giving greater length to the suspending-wire, and for making the suspension-piece more accessible. This instrument is used for photographic self-registration only.

"Upon the superstructure of this pier is planted the original framed wooden stand, for carrying the original 2-feet magnet vertically above the photographic magnet. Hitherto this magnet has been so mounted that its attached collimator was right or left of it; it is now so mounted that the collimator is above or below it; and with this arrangement, on reversing the collimator and giving the necessary movement for making the collimator-axis coincide with the axis of the theodolite-telescope, the magnet is still vertically above the photographic magnet in the basement.

"The theodolite, with which the magnet-collimator is viewed, and with which circumpolar stars are also viewed, is in the same position as formerly; a brick pier being built up from the ground below the floor of the Magnetic Basement, through the basement, and through the floor of the upper room, to carry the theodolite.

"For the support of the horizontal-force magnet, a pier is built of brick, stone, and slate, which, like that of the declination-photographic magnet, projects through the upper floor into the upper room.

"The suspending-cords of these three instruments are of steel wire. I have seen no practical reason for objecting to the silk skeins; yet, on theoretical grounds, I have long since determined, when opportunity shall present itself, to make this change.

"The new vertical-force instrument differs from the old one in the following points:—First, the length of the magnet is 18 inches instead of 2 feet. Secondly, its ends are pointed; a construction indicated by Lamont as giving great magnetic power, which, however, is not successful in the present instance. Third, the knife-edge is one continuous piece of steel. Fourth, the whole of the frame which connects the knife-edge with the magnet is of

iron. I am not able yet to say whether any practical advantage attends these modifications.

"The new positions of the vertical-force and horizontal-force magnets are vertically below their former positions. That of the declination-magnet is about 10 inches north of its former position.

"I have now to mention a result of late observations which has given me great anxiety.

"The variations in the power of the horizontal-force and vertical-force magnets depending on temperature were determined several years ago with very great care by experiments in which the magnet was immersed in water of various temperatures. It is evident, however, that this form of experiment does not exactly reproduce the circumstances of a magnet whose temperature depends on that of the external atmosphere; and I have long contemplated experiments in which the magnet should be heated, not by water, but by air.

"Opportunity seemed to be given by the command of the hot-air stove, constructed entirely of copper, and heated by gas, which was provided for the warming of the Magnetic Basement. I had a copper box prepared to fix on the top of this stove, containing facilities for the placing of the magnet (to be tried) in a definite position, for the distribution of the heated air over its length, and for reading three thermometers in different parts of its length. The degree of heat was regulated merely by turning the tap of the gas-pipe at the floor—a manipulation which could not affect any part of the apparatus. The stove was placed in a position convenient for producing deviation, by the magnet enclosed in the copper box, on the needle of the Kew Unifilar.

"The result of these experiments is to give a coefficient for temperature-correction four or five times as great as that given by the water-heatings. And this applies to both the magnets (horizontal force and old vertical force), in which I am able to compare the two systems of experiment. A large coefficient is also given for the new vertical-force magnet, though much smaller than that for the old one, when tried in the same manner.

"I cannot discover any peculiarity in the apparatus which can produce the smallest error. The only differences between the modes of action in the two experiments are, that in the former or water-experiments the magnet was 'end-on' to the deflected magnet, while in the latter or air-experiments it was 'broadside-on;' and that in the former experiments the magnet travelled round to a position definite with regard to the axis of the deflected magnet (in which case its power is measured by the sine of deviation), whereas in the latter it was stationary (in which case its power is measured by the tangent of deviation).

"For the rotating cylinders upon which the photographic paper is placed, and which have hitherto been of glass, being merely glass shades selected with great care from the large stock of a vendor of glass ornaments, I propose to try ebonite. This material is very light, but is firm; it turns well in the lathe, and presents a very smooth surface. I expect that a little accuracy will

thus be gained in the subdivisions of the time-scale on the photographic sheets.

"The self-registering apparatus for the record of results of the earth-current wires is ready in all important points, but its mounting is delayed for the completion of the magnetic basement.

"The meteorological apparatus is in good order. Some of the instruments—the barometer, the dry and wet thermometers, the anemometers, and a pluviometer—are adapted (like the three magnetometers) to automatic continuous register as well as to occasional eye-observation. Other instruments—as several pluviometers at different elevations—exhibit accumulations, to be occasionally read by eye. Others—as the maximum and minimum thermometers in the air and in the Thames—register extremes only, and require to be read every day. The electrometers (which communicate with a wire that extends from a warmed glass pillar upon the electrometer-mast to a warmed glass pillar upon the north-west turret of the Octagon Room) are only useful when the eye is turned towards them; until satisfactory means of self-registration can be arranged, these instruments are nearly useless.

"I am preparing to erect, near the entrance-gate of the Observatory, a barometer for public information. Only the graduated face will be exposed. Upon this the scale of graduations will be much enlarged. Indexes are arranged for exhibiting the present state of the barometer, the last maximum and the last minimum.

"*Magnetical and Meteorological Observations.*—The barometer and dry and wet thermometers are read several times every day, and the maximum and minimum thermometers once every day, to the present time. The eye-observations and the photographic record of the three magnetometers have necessarily been suspended since January 25; but the photographic record of the barometer has been continued to May 10, and that of the thermometers is still maintained. Dips have been observed twice each week, or oftener. Observations for absolute measure of horizontal magnetic force about three times in a month.

"In the present year, commencing with January 1864, sixty series of observations on twenty-three days have been made with the actinometer.

"With the gratuitous assistance of the London District Telegraph Company and the Submarine Telegraph Company, we every morning communicate to M. Leverrier the state of weather and the readings of barometer and thermometer, which, with those from other parts of Europe, are published in the 'Bulletin.'

"*Reduction of Magnetical and Meteorological Observations.*—The equivalents for eye-observations of the three magnetometers, and the temperature-corrections for two, are applied as far as the suspension of photographic records on January 25; the reading for astronomical meridian is reduced and applied to 1863, December 31. The time-scales are attached to the photographs as far as 1863, December 31; the new base-lines for the declination and horizontal force to 1863, June 30; for the vertical

force to 1863, December 31. The deflexion-observations are reduced to 1863, December 31. The dip-observations are reduced to the present time.

"The mean magnetic declination for 1863 is about 20° 46′; the diminution from the preceding year about 6′. The mean dip for 1863 is about 68° 4′. The diminution from 1862 appears to be about 7′. The dip at the present time appears to be 68° 2′; but this depends partly on C_1, which always gives a large result. It is remarkable that this is the needle whose magnetism, as above stated, appears to be so unsteady.

"The barometer-photographs are in the same state as the vertical-force photographs upon the same sheet, to the end of 1863. No step of reduction is taken for 1864.

"The thermometer-photographs are nearly in the same state.

"The vane of Osler's anemometer made about +28·5 complete revolutions in the year 1863—the largest number that we have yet observed.

"In the last Report I alluded to the numerical discussion of the magnetic storms, 177 in number, registered from 1841 to 1857, the treatment of which was then far advanced. In the last autumn I finished the discussion of these; the results have been placed before the Royal Society, and are printed as a memoir in the 'Philosophical Transactions.' They appear to me entirely to support the idea that storm-disturbances cannot be explained by sudden magnetic attractions or sudden galvanic currents, but require the supposition of currents, like air-currents or water-currents, upon the surface of the earth.

"*Printing of Magnetical and Meteorological Observations.*—I have thought it desirable to commence the printed record of the observations of 1862 with an Introduction written at considerable length. The last detailed Introduction is that in the volume for 1847 (the last separate volume of detailed magnetic and meteorological observations); and, though changes in instruments and methods have been noted in the briefer Introductions preceding the 'Results of Magnetic and Meteorological Observations' attached to the 'Astronomical Observations,' yet it appeared advantageous now to collect the results of all, and to exhibit fully the present state of the magnetical and meteorological establishment. The manuscript is in the printer's hands, and the printing is in progress.

"The indications of the magnetometers are printed in the same form as in preceding volumes commencing with 1847; exhibiting the numerical values, expressed each by its proper scale, of the ordinates of all the salient or conspicuous points of each photographic curve. The printing of these is very nearly finished for 1862. The other magnetic observations are prepared for printing in different degrees of detail; the manuscript is in the hands of the printer. An appendix contains the 'Abstract of the Reduction of the observations of Magnetic Storms' (to which I have alluded above), in form intermediate between the exhibition of instrumental indications and the analysis in the 'Philosophical Trans-

actions;' the printing is far advanced. The meteorological observations for 1862, in abstract only, are printed.

"As the long Introduction and the Storm Abstracts increased the size of this portion of our printing, I have deemed it expedient, for 1862, to direct that it be bound in a separate volume. The number of copies is 600, of which I propose that 350 be considered as a second part of the astronomical volume, and that 250 be circulated separately as heretofore.

"For 1863, the indications of declination magnetometer are prepared to February 26, those of horizontal force to May 31, and those of vertical force to July 31. The meteorological abstract is more than half finished; the following tables nearly complete.

"It is known to the Visitors that I have every year prepared photographic copies of the photographic curves, for future use or communication to others. These copies can only be formed by the transmission of sunlight through the originals; and, in order to give the desired vigour and clearness to the copies, it is often necessary to touch the originals with sepia or other dark pigment. It has been matter of great regret to me that the delicacy of the original is frequently much injured by this process. I have at length devised a method which removes all difficulties. An apparatus is constructed, consisting of a horizontal looking-glass, and a sheet of clear glass erected over it in the position of a desk. The photographic sheet is laid upon this desk with its face downwards; the photographic curve is seen in the utmost perfection by light reflected from the looking-glass and transmitted through the paper; and the sepia is laid on the back of the paper, without touching the original photographic trace at all.

"Two copies of each of the photographic curves for declination and horizontal force have been taken to 1861, December 31, and two for vertical force to 1862, April 30."

KEW OBSERVATORY.—Meteorological instruments continue as heretofore to be verified; also the barograph and self-recording electrometer are kept in constant operation.

During the last year, experiments have been completed, the object of which was to ascertain by means of an air-thermometer what is the increase between 32° and 212° F. of a constant volume of dry atmospheric air, and also to fix the melting-point of pure mercury.

According to these experiments (the increase of elasticity of a constant volume of air for 1° F. being denoted by α), we have $1+180\,\alpha=1{\cdot}36728$.

Also, by one set of experiments the temperature of melting mercury was found to be $-37^\circ{\cdot}91$ F.; while, by another set, it was found to be $-37^\circ{\cdot}95$ F. These two determinations agree together extremely well, giving $-37^\circ{\cdot}93$ F. as the mean value of the melting-point of mercury, which is likewise found to be strictly constant when the experiment is conducted with ordinary precautions.

In these experiments the mercury was well purified and frozen by means of solid carbonic acid and ether. The carbonic acid was purified through the kindness of Mr. Robert Addams, of London.

It was likewise ascertained, in the course of these experiments, that different specimens of purified mercury have precisely the same specific gravity; and therefore, if used in the construction of standard barometers, these instruments would not exhibit, when compared together, any difference in height due to difference in density of the fluid employed.

RADCLIFFE OBSERVATORY, OXFORD.—No important change has taken place in the making or reducing of the meteorological observations since the last Report of the Society.

The self-registration of the pressure, temperature, and moisture of the air, and of the velocity and direction of the wind, have been kept up without interruption, under the immediate superintendence of Mr. Lucas, as in the preceding year; and the photographic sheets have been brought to a state of great perfection, by his unremitting care and attention to the minute details necessary for successful manipulation.

Advantage was taken of the violent storms which occurred in October and December of last year to compare the registers with those of Greenwich and Kew; and the interesting results of the comparison have been communicated to the Society by Mr. Glaisher*, Mr. Balfour Stewart†, and Mr. Eaton‡. Independently of the instructive facts elicited by the comparison, it is particularly valuable as showing the importance of the establishment of apparatus for self-registration at every important station in the British Isles, for the improvement of our knowledge of the law of storms.

At the beginning of the present year were published the Oxford meteorological observations of 1861, discussed in the same manner as in former years; and considerable progress has been made in the reduction and discussion of those for 1862.

THE METEOROLOGIC OFFICE of the Board of Trade, under Vice-Admiral FitzRoy, increases in activity. Weather-tables for the previous day, and forecasts of the probable weather for the two following days, appear as usual in the daily papers. The Report for 1863 was published on the 22nd of April, 1864, 37 pp. 8vo, with a new form (one blank, another filled in), for "the farmer, gardener, sailor, or any other observer;" also eight synoptic charts, of which three have reference to the 'Royal Charter' storm, October 25 and 26, 1859; and four to the storm, December 1 to 4, 1863.

* *Vide* Proc. Brit. Meteor. Soc. vol. ii. No. 9. p. 12; and No. 10. p. 48.
† *Ibid.* No. 10. p. 51.
‡ *Ibid.* No. 11. p. 108.

The department have also published 'Coast or Fishery Barometer Manual,' 5th edition, 8vo, pp. 30, plate and diagram.

'Arrangements for Meteorological Telegraphy,' 8vo, pp. 31.

The following are extracts from the Preface to the Report:—

"Demands have increased for cautionary notices of strong winds, such as would affect the smaller and less efficiently provided vessels, or, when increased to gales, if not to storms, might delay, injure, or occasion risk even to well-found ships.

"Not only are such notices sent day by day regularly to Paris for the French coast, but occasionally to Hanover and to other places near the North Sea, in consequence of special applications made by foreign governments.

"Italy is adopting the methods of weather-warning originated at our Board of Trade, and no less than twenty-six stations are intended to be formed, under the direction of Signor Matteucci, with a committee at Turin.

"In ten years, an accumulation of valuable log-books, observatory registers, and miscellaneous records has been effected here. Many years must elapse before these stores and those of the Admiralty (at Somerset House) can be so *nearly* exhausted that more supplies of facts than those still continually added, as selected ships arrive, may become requisite.

"In my last Report I stated how highly the Board of Trade 'fishery' barometers have been valued on the coasts. They are now eighty in all, specially *lent, under due control and care.* Two only of this number have become slightly defective, and have been exchanged. Not one has been injured in carriage (singular to say) between Cornwall and the Shetland Isles, Ireland and Yorkshire. It may be more readily *estimated* mentally, than accurately proved, to what extent these simple instruments (all reliably made and tested) have already been the means of saving life and property. Explanatory manuals and blank forms for diagrams have been extensively circulated among the coasters and fishermen, who are all now much influenced by, and very thankful for, the benefits of this act of their Government. Many are the local instances of similar beneficence by individuals—especially the Duke of Northumberland, who has placed no less than fourteen barometers.

"It may now be asked, What is our actual degree of acquaintance with atmospheric changes and their indications? In answer, I submit that our knowledge is already sufficient for practical purposes, and may be communicated to a fairly educated and able person. Ability and due preparation are of course as indispensable as for other results of study and practice.

"That we have proved experimentally how winds and weather may be foretold with *general* accuracy for two days at least in advance, our reports since 1861 have shown, if insufficiently at first, certainly to the satisfaction of a large majority at present. That we are acting on true principles our results leave not a doubt on my mind (and, in stating this, I may be pardoned for alluding to unintermitted attention to meteorology which special avoca-

tions, in all oceans, and at many places on land, have induced, during forty years of observation). But to act judiciously, with sufficient rapidity, on even unerring principles, is and must ever be more or less difficult.

"Few persons examine the daily newspaper reports in ordinary weather; but, if they would do so occasionally, for some days together, they might be surprised at the close approximation to accuracy now to be found in them, even to the way winds are likely to veer or shift, often as they do so, in changeable weather, during even one day and night. The negative evidence, or the security against storm during a certain time, which these two-day tables show, will be more appreciated in due time, as they become more criticised and understood.

"It has been asked, 'If you are absent, who carries on the responsible duties of forecasting, and giving cautionary notices when necessary?' My reply has been to the effect that an assistant is fully acquainted with the subject, and has not only executed these very duties often during the last two years, but has done so *generally* since last autumn, occasionally relieved by me, to whom he refers at times, though now but seldom. Besides ourselves, there *ought* to be two or three in training for these special duties, now systematically established."

Admiral FitzRoy reports that there is nothing else in *print new*, but a great deal of material is in preparation for the press, chiefly tabular.

RAIN-FALL.—The collection of rain-fall observations, commenced in 1859 by Mr. Symons, is by him being continued with a degree of success, which may be inferred from the following facts respecting the progress last year. First, as to the number of stations whence complete returns of the fall of rain in 1863 were received, viz. 641. It may be well to remark that, prior to the issue of Mr. Symons's first list for 1860, it is believed that not more than 60 or 70 returns for any one year had been published collectively. The number of returns which he was able to collect for 1860 was only 168; but in 1861 this was increased to 474; in 1862, 584; and last year, as above mentioned, to 641. Of course, the number of stations is much, perhaps 100, greater; but accidents to the instruments, errors in observing, and the absence of observers continually prevent the full number of returns being published.

Major Ward's experiments at Calne, to which reference was made in the last Report, were commenced shortly after it was written; but as it is probable that a full description will before long be presented to the Society, it is unnecessary now to enter further into details, than to state that the gauges are 20 in number, vary in size from 1 inch to 2 feet in diameter, and in height from level with the ground to 20 feet above it; that they were constructed by two of the first London firms, tested by Mr. Symons, and their erection entirely superintended by him.

With the view of ascertaining whether the results, hereafter to be deduced from the Calne experiments, are equally applicable in

districts where the character of the rain-fall is different, a somewhat similar, but less extensive, set of instruments have been erected by the Rev. J. Chadwick Bates, at St. Martin's, Castleton Moor, Manchester; they were made by the same firms, and also tested before despatch.

The British Association having, at Newcastle, voted the sum of £20 for the supply of rain-gauges to districts where observations have not hitherto been made, a letter was inserted in 'The Times,' announcing the same, and inviting persons resident in certain specified localities to apply for instruments, which would be supplied (on loan) gratuitously. About 200 replies were received. The grant, however, would only provide 18 gauges. About thrice as many more were paid for by the parties themselves; and, of the remainder, part were declined as unnecessary, and part await a further grant for the same purpose.

The total number of new stations obtained, directly or indirectly, by this means will not be much under 100; although the number is of little import, compared with the fact that a large proportion of them are in the most remote parts of the United Kingdom, especially in Ireland. And it must not be forgotten that a gentleman (or lady) who begins by keeping a rain-gauge, generally ends by keeping a full meteorological register.

Steps have recently been taken to secure a chain of stations round Snowdon and over the greater part of North Wales, where, from the physical configuration of the district, it seems not improbable that the rain-fall is similar or even perhaps greater than in Cumberland.

Mr. Symons's recent illness has prevented his taking the personal superintendence of the erection of the gauges; but he designed and tested a considerable number before he left town, and has every confidence that Captain Mathew (who bears most of the expense) will have them suitably placed.

The examination of the gauges in different parts of the country proceeds steadily, but rather slowly from two causes, illness and the expense of continual travelling, all of which falls on Mr. Symons.

Forty-three stations were visited last year.

Two subjects have specially occupied the attention of the Council during the present session—the Register or List of Members, and a Royal Charter of Incorporation.

Your Council, in their Report read at the Annual Meeting in June 1862, expressed their opinion that the day could not be far distant, when they would "feel justified in taking the sense of Members as to the propriety of seeking for a Royal Charter of Incorporation*." The day has now arrived. Members have been advised that the Council, at their Meeting held on March 16, 1864, passed a resolution:—"That it is desirable, in the opinion of this Council, that this Society should make application for a

* *Vide* Proc. Brit. Meteor. Soc. vol. i. p. 224.

Royal Charter." The opinion of the Society on this question will be taken today. Members are aware that the Society, as now organized, possesses no legal corporate existence. No great inconvenience would arise out of this during the infancy of the Society. But now that we have acquired property of no small value, that is to say, a large and increasing Library and a considerable sum of money*, at present invested in government stock —£800 of stock—representing the contributions of Life Members, whose interest we have specially to regard, it appears to your Council that it would be the duty of the Society, as well as an act of common prudence, to present a petition to the Crown, humbly praying that Her Majesty would be graciously pleased to grant a Royal Charter for Incorporating into a Society the several persons who have already become Members.

As a corporate body, the Society would possess greater usefulness, and would be better able to promote a general spirit of inquiry on meteorological subjects. They would have perpetual succession; the Council and Members for the time being would be connected with all who had preceded them by legal descent; and the lawful contracts made by one Council would be binding on their successors. This question is of considerable importance to Life Members. A chartered Society has power to purchase, to receive, and to possess property in goods, and, under certain restrictions, in land and houses. We have possessed ourselves, it is true, of certain property; but if troubles were to gather round us, it would not be a very easy thing to establish legal ownership for what we have acquired. The then Members, being in no degree successors by law to the past Members who had purchased or accumulated the said property, could scarcely expect to establish a legal claim to the then proceeds. We are unable to appear in a corporate form in a court of equity; we cannot sue or be sued. Our Members are in the strictest sense volunteers; they can pay their subscriptions or not, as it seems good to them. We have no power to deal with an intractable Member whose subscriptions are in arrears. Payment is purely gratuitous. Our debts, should we have the misfortune to fall into debt, are not the debts of a body politic and corporate; they reduce themselves to the debts of the individual by whose order they were incurred. Members will see in this another reason in favour of a Charter; they will be glad to feel that their Officers are relieved from a responsibility of this nature.

Your Council, for these and other reasons, consider it would be very advantageous to the existing Members, and to all others who may hereafter be elected, to terminate the present unstable form of existence, and to endeavour to acquire legal power to act and do in all things, as fully and effectually to all intents and purposes whatsoever as any other body politic and corporate can act and do; and that every person, and other bodies politic and corporate, might be able to negotiate legally with this Society. It will be for the Members at this meeting to elect the style or title of the

* The figures, p. 260, extend only to December 31, 1863.

proposed corporate body, and with it the distinctive title of the Fellows; whether to retain the designation "British Meteorological Society," and the title F.B.M.S., or to drop the word "British" and elect to hold the title F.M.S.: neither of these distinctions are in use with any other Society.

Before leaving this subject, the Council have the pleasure to report, that one of our more recently elected Members, who is a solicitor, has kindly volunteered to give us gratuitously his professional assistance in preparing the petition, and furthering the resolution of the Society, with the view of obtaining the proposed Charter.

The necessary fees are considerable. But the Council do not propose to recommend the employment of the capital of the Society, that is to say, the money invested in the funds, for this purpose; neither to charge the expense to the ordinary revenue account. They prefer to follow the course commonly, if not invariably, adopted by other societies, under like circumstances, of raising the necessary amount by subscriptions among the Members. Several names of subscribers have already been given in; and, in the event of the Members at this Annual Meeting approving of the propositions that will be placed before them, no time will be lost in circulating notices for contributions for this purpose, and in taking the preliminary steps.

In anticipation of this becoming a Chartered Society, the Council have devoted considerable time to the examination of the Register of Members, and to the collection of any outstanding arrears, in order that the name of no one should appear on the List of Members (of which first proofs are now before the Society) who has not complied with the rules in the Institutes having reference to the payment of subscriptions. The Council have so effectually carried this out, that they have the satisfaction of being able to report that at this present time there are no arrears of subscriptions due to the Society (Rule 20). The balance in hand is £120.

The following is a tabular statement of the present strength of the Society, including the new Members that have been elected this evening:—

	Members.			Totals.
	Life.	Ordinary.	Honorary.	
1863, June 17	32	240	10	282
Since Elected...........	8	40		48
Since Compounded ...	15	−15		0
Deceased	−1	−9		−10
Retired	...	−10		−10
Defaulters	...	−10		−10
1864, June 15	54	236	10	300

The total number of new Members elected this Session is 48. Deducting from this those who are deceased, who have retired, or who were found to be defaulters, 30 in all, the total addition to the numbers is 18; and the Council have great gratification in saying that these are all true and proper Members, from not one of whom are arrears of subscriptions due. A few words of explanation as to the Members who have retired. The majority are Members who had long since considered that they had retired, and were under the impression that the Council were aware of their retirement. Their names had not, however, been before the Council until the list was under revision, or they would have been erased, according to their wishes, before this. There were a few names only that had practically ceased to be Members, having withdrawn their annual subscriptions. These names also have been removed.

The following Table shows at a glance the number of existing Members elected in each of the Fifteen Sessions, and is a satisfactory index to the present prosperity of the Society; more of the existing Members (namely, 162) having been elected during the last three Sessions than in the previous twelve Sessions (138 in all).

SYNOPSIS of Members of the British Meteorological Society on the Register, 1864, June 15.

	Members elected each Session.			
	Life.	Annual.	Honorary.	Totals.
1st Session, 1850	16	26	1	43
2nd „ 1850-51 ...	3	16	3	22
3rd „ 1851-52 ...	3	3	2	8
4th „ 1852-53 ...	1	2	...	3
5th „ 1853-54 ...	1	7	1	9
6th „ 1854-55 ...	...	7	1	8
7th „ 1855-56 ...	2	12	...	14
8th „ 1856-57 ...	3	4	...	7
9th „ 1857-58 ...	1	2	...	3
10th „ 1858-59 ...	2	2	...	4
11th „ 1859-60 ...	1	13	...	14
12th „ 1860-61 ...	2	1	...	3
13th „ 1861-62 ...	7	59	2	68
14th „ 1862-63 ...	4	42	...	46
15th „ 1863-64 ...	8	40	...	48
Total on Register	54	236	10	300

The revised edition of the List of Members, from which the above Table is extracted, will be forwarded to Members with this Report.

The deceased Members are—

H. Ancell, Esq., F.R.C.S., who had been elected into the Society on February 22, 1853.

T. E. Blackwell, Esq., elected June 4, 1850.

Beriah Botfield, Esq., M.P., F.R.S., &c. &c., who was elected June 18, 1862, and compounded.

John Brown, Esq., who was elected January 24, 1854.

J. Gibbs, Esq., C.E., elected June 18, 1862.

F. Hopkins, Esq., elected March 19, 1862.

Luke Howard, Esq., F.R.S., who had been a Member since the foundation of the Society, having been elected on May 7, 1850.

George Leach, Esq., F.Z.S., who died February 19, 1864. He also was an original Member, having been elected May 7, 1850; and was President during the Fourth and Fifth Sessions, 1853–55.

Hugh Lee Pattinson, Esq., elected May 27, 1856.

Admiral John Washington, R.N., F.R.S., &c., who was elected November 27, 1855.

Beriah Botfield, Esq., of Norton Hall, in the county of Northampton, and of Hopton Court, and Decker Hill, Shropshire, M.P., M.A., F.R.S. (1839, Jan. 17), and F.S.A., was the head and representative of a branch of the ancient Shropshire family of Boteryle, Boteville, or Botfield. He was the eldest son of Beriah Botfield, Esq., of Norton Hall, by his wife Charlotte, daughter of William Witherington, M.D., of "The Larches," near Birmingham. He was born March 5, 1807. He was educated at Harrow, the school of which he subsequently endowed with the "Botfield Medal for Modern Languages." From Harrow he proceeded to Christ Church, Oxford, and took his degree of B.A. in 1828 and M.A. in 1847.

He entered Parliament as member for Ludlow, in the Conservative interest, in 1837. From that time he sat till 1847. He was re-elected for the same borough in 1857, and continued to be its representative until his death. Mr. Botfield's scholastic and antiquarian attainments acquired for him a wide-spread reputation. He was a Fellow of the Royal Society and of the Society of Antiquaries, and a prominent Member of, and also Secretary to, the Roxburgh Club, and belonged to many other learned institutions. He was also, for his merit as a scholar, made a Chevalier of the Saxon Order of Albert the Brave, and a Knight of the Belgian Order of Leopold. Mr. Botfield took much interest in all associations connected with learning, and was particularly grateful to his early school, Harrow. He made munificent contributions to the library of that public foundation. Mr. Botfield was the author of many works; among others, 'A Tour in Scotland,' 'Notes on the Libraries of the Cathedrals of England,' and 'Stemmata Botevilliana.' He married, October 21, 1858, Isabella, second daughter of Sir Baldwin Leighton, seventh and present Baronet, of Watlesborough, Shropshire. Mr. Botfield was a Deputy-Lieutenant for North Hants and Shropshire, and was High Sheriff of Northamptonshire in 1831.

Mr. Botfield was principally distinguished as a bibliographer, in

which pursuit he was almost unrivalled. He published several works on bibliographical and antiquarian subjects, and communicated numerous papers on similar subjects to the 'Gentleman's Magazine' and other periodicals.

His library at Norton Hall, Northamptonshire, is chiefly remarkable for a fine collection of *editiones principes* of classical authors, and costly folio editions of illustrated works. He died on the 7th of August, 1868, at the age of 56 years.

Admiral WASHINGTON was born on the first day of the present century. He entered the Navy on May 15th, 1812, as a first-class volunteer on board the 'Junon,' forty-six guns, Captain James Sanders, fitting for the North American station, where he took part in many operations in the River Chesapeake. He assisted in making prizes of several of the enemy's vessels, and contributed to the complete discomfiture of fifteen gun-boats that had been dispatched for the express purpose of capturing the 'Junon,' after an action of three hours, fought on June 20, 1813. Removing as midshipman in the following October to the 'Sibylle,' he sailed in that ship in 1814, under Captain Forrest, with the 'Princess Caroline,' Captain Downman, for the latitude of Greenland, in fruitless pursuit of the American Commodore Rogers. In November of the same year, having returned to England, he entered the Royal Naval College at Portsmouth, and this unquestionably was the turning-point in his career. Naturally of studious habits, he turned to the greatest advantage the opportunity afforded him of improving his education; and the mental training he thus received enabled him in subsequent years to improve the talents he possessed, not in the accumulation of wealth, but in advancing the interests of his profession, and in helping forward the cause of humanity. On leaving the Royal Naval College, he was received, in May 1816, on board the 'Forth,' Captain Sir Thomas Louis, under whom he was again employed for upwards of three years on the coast of North America. He then in succession joined the 'Vengeur' and the 'Superbe,' both on the South American Station, where he remained until after his promotion to the rank of Lieutenant, which took place on the 1st of January, 1821. He was subsequently employed on particular service, and in August 1830 was appointed to the 'Royal George,' 120, as Flag-lieutenant to Admiral St. John Poer Beresford, Bart., Commander-in-Chief at the Nore—continuing to serve under that officer, in the 'Ocean,' until advanced to the rank of Commander in 1833.

To the active service consequent upon his various appointments he had united the practice of maritime surveying, and the combined pursuits of a scientific hydrographer and geographer. In 1835 he succeeded Captain Maconochie as Secretary of the Royal Geographical Society of London, but resigned that office in 1841, on being appointed to continue the survey of the North Sea, which had for some time been in progress. During this undertaking, in which he was continually engaged until the close of 1844, he was necessarily occupied in correcting the existing charts, as the posi-

tions of the shoals and the directions of the navigable channels had in many cases become changed. This service was strikingly useful, and led in a great degree to his subsequent appointment as a Royal Commissioner on certain important questions respecting the construction of harbours of refuge on exposed coasts of the country.

In 1842 he was appointed to the rank of Post-Captain, in compliment to the King of Prussia. This survey was Captain Washington's last service afloat. In 1845 he was appointed a member of a Royal Commission for inquiring into the state of the rivers, shores, and harbours of the United Kingdom, the duties of which office brought him into contact with a large number of our seamen and fishermen, in whose welfare he took unceasing interest from this period until the day of his death.

He was subsequently engaged in an inquiry into the condition of our large fisheries on the north-east coast of Scotland. His able Report, and the clear plans of the different classes of fishing-boats which accompanied it, prepared expressly by Mr. James Peake, Master Shipwright of Her Majesty's Dockyard, Devonport, deservedly attracted considerable attention.

"When we remember," said the late Admiral, "that the fishing-boats of the United Kingdom number probably 36,000, manned by 150,000 men and boys, it will be admitted that this class of men deserves some consideration, and that, as far as may be, their small harbours should be deepened, to enable them to obtain shelter in time of need, and at all states of the tide."

In 1853 Captain Washington visited some of the Russian fortresses in the Baltic. In the following year the war broke out, and the results of his acute observations during that tour proved of the greatest value. He was thus enabled to give most important information regarding the character of those fortresses, which could not possibly be obtained from any other recent and reliable source. His experience was afterwards turned to good account by the assistance he continued to render, during the whole period the war lasted, to the Admiralty.

In the year 1855 he was appointed by Sir James Graham, Bart., M.P., then first Lord of the Admiralty, to the responsible office of Hydrographer of the Admiralty on the retirement and special recommendation of the late Admiral Sir Francis Beaufort, F.R.S., to whom he was much attached. With reference to this appointment, Sir James stated, in the House of Commons, at the close of the Russian war in 1856, that during his long official life no appointment made by him had afforded him more satisfaction than that of Admiral Washington. To the responsible duties of that office he devoted himself with such assiduity, that his valuable life was unquestionably brought to a premature end by mental over-exertion in connexion with it.

"When first appointed to the surveying service," writes a gentleman who had served under Admiral Washington in that department, "no officer could have carried on the duties with more zeal, activity, and intelligence. His zeal and abilities were con-

spicuously shown forth by the mass of information he published to the world during the few years he was at the head of the Hydrographic Office, in Charts, Sailing-directions, Tide-tables, &c. Indeed, he had not held that appointment above three or four years before he had arranged for publication the results of numerous nautical surveys and other useful professional information which had accumulated in the office. His quickness and clearness of judgment in revising charts and other office works were conspicuous to every one, and the amount of work he undertook and accomplished showed his great application and abilities."

In 1858 Captain Washington again became a Member of the Royal Commission to inquire into the proper sites for Harbours of Refuge along the coasts of the United Kingdom. We are informed that the remarkable extent of his local knowledge of the districts visited by this Commission, and his active and painstaking habits, were of great value to the Commission; indeed, that it was looked upon by him as one of the crowning efforts of his labours in the cause of humanity and on behalf of his humbler professional brethren.

Thus he continued to discharge, without intermission, the onerous duties of his office. Returning in the evening to his own home, these duties were occasionally pursued until the early hours of the morning. He was thoroughly devoted to his profession, and especially to all matters connected with hydrographic science; and no labour, no trial, was too great for him, so long as his public duties were satisfactorily discharged.

In the year 1862 Captain Washington was promoted to the rank of Rear-Admiral, and in the same year one of his last public labours was to act as a Juror at the International Exhibition of 1862. He was unanimously elected Chairman of the section which embraced those objects he had so long studied.

His funeral took place at the Protestant cemetery of St. Marie, Havre, on the 19th of September, with every demonstration of respect on the part of the foreign authorities of the town. Admiral Washington's character was much valued in France; and in consequence, immediately his decease became known, the heads of departments at Havre—civil, naval, and military—expressed their desire to attend the funeral. Officers and men of the Imperial yacht 'Prince Jerome,' to the number of forty, formed part of the *cortége*, which comprised forty carriages. The English ships in the harbour hoisted their colours half-mast high, and the captains of two large steamers volunteering the attendance of six of their seamen as bearers, the offer was gratefully accepted by the family. The French authorities all attended in full uniform; and the inhabitants of Havre, thronging the streets, silently and reverently testified their respect and regret. The naval Aide-de-camp to the English Embassy in Paris, and another English naval officer, Lieut. E. W. Brooker, R.N., K.L.H., were also present. The unexpected sympathy shown by the French in thus honouring the Admiral's memory was gratefully felt and acknowledged as a consolation by his afflicted family; and the Lords Commissioners of

the Admiralty afterwards expressed officially to the authorities of Havre their deep sense of the honours so gracefully bestowed.

Thus closed the life of one of the most valuable officers in Her Majesty's service. That his years should have been cut in the midst of an active professional life must be to Admiral Washington's friends an occasion of regret; but they may, however, feel grateful that so much has been accomplished by him.

Luke Howard, one of the fathers of meteorological science, has lately disappeared from amongst us, at the advanced age of ninety-two years. Luke Howard was born in London in the year 1772, the son of Robert and Elizabeth Howard, of Stamford Hill. He was sent for seven years to the school of a Mr. Huntley at Burford, in Oxfordshire, and there, whilst his school hours were devoted too much to Latin and too little to anything else, as he often said in after-life, his leisure was devoted to science. Young as he was, his observing eye had begun to be attracted by the varying beauties of the cloud-streaked sky; and something doubtless of the same pleasure was thus ministered to him, amid the lowland landscapes of Middlesex and Oxfordshire, which the child of the mountaineer derives from his daily friendship with the rocks and waterfalls of his home. He himself specified the great fog of 1783 (alluded to in Cowper's 'Timepiece'), the marvellous meteoric appearances of that year, and its frequent magnificent displays of the aurora borealis, as having powerfully assisted in turning the energies of his boyish intellect towards meteorology.

On leaving school he was bound apprentice to a Mr. Sims, a chemist at Stockport, and in the year 1798 he entered into partnership with Mr. William Allen as a wholesale and retail chemist at Plough Court, Lombard Street. They established a laboratory at Plaistow, which was subsequently removed to Stratford-le-Bow, where it still remains in the hands of his children and grandchildren.

In the year 1796 he married Mariabella Eliot, with whom he received a considerable fortune, and by whom he had three sons and three daughters. He was much interested in many of the philanthropic enterprises of the early part of the century, and he entered with especial ardour into a movement for raising subscriptions to alleviate the sufferings of the Germans in the two last campaigns of Napoleon which preceded his first abdication; and his exertions in this behalf were gratefully acknowledged by several of the sovereign princes and free cities of Germany.

For several years before his death he retired from all active pursuits, residing near Ackworth, and latterly, after the decease of his wife, at the house of his eldest son at Tottenham, where, on the 21st of March, 1864, a peaceful end closed a varied life extending over the greater part of a century. The following extract from 'The Friend' will give Members a sketch of his scientific labours:—

"During his residence at Plaistow, he published the paper on the 'Modifications of Clouds,' upon which his reputation as a

man of science chiefly rests. It was the result of these early boyish musings, enriched, as he himself tells us, by the observations of many a walk or ride, morning and evening, to or from his day's work at the laboratory, and finally thrown into the form of a paper in order to meet the requirements of the *Askesian* Society, a little philosophical club to which both W. Allen and he belonged, and which, at its fortnightly meetings, demanded from each of its members, in turn, an essay on some scientific subject, or else the payment of a fine. Luke Howard's paper was read in the session 1802–3, and, being deemed worthy of a wider audience, was published in the latter year. In the year 1818 he published his 'Climate of London,' which had previously appeared monthly in the 'Athenæum.' It contains the collected records of his meteorological observations, commencing with the year 1806. In later life he published his 'Lectures on Meteorology,' the 'Barometrographia,' and the 'Cycle of the Seasons'; but these works are hardly equal in value to his early performances. It has been well said of him, 'He was a pioneer in meteorology, and kept public attention directed to it as a science, by always himself treating it as such.' The mere mechanical appliances which have been introduced since his day, by rendering observation more exact, have deprived some of his more elaborate theories of their value; but the simple work of classification of the clouds, depending chiefly on a quick eye for form and colour, and on the possession of the philosophic habit of mind, still remains; and all over the globe, wherever scientific observers are to be found, the clouds are still known by the names whereby he named them. His meteorological labours procured for him the position of F.R.S.—he was elected 1821, March 8—and the friendship and correspondence of some of the most eminent *savans* of Europe; yet never, probably, was science wooed more entirely for her own sake—never was there a more thorough 'labour of love' than that which he thus bestowed. One of his family, who was the constant and devoted companion of his later years, says, 'Those who lived with him will not soon forget his interest in the appearance of the sky. Whether at morning, noon, or night, he would go out to look around on the heavens, and notice the changes going on. His intelligent remarks and pictorial descriptions gave a charm to the scene never before realized by some. A beautiful sunset was a real and intense delight to him; he would stand at the window, change his position, go out of doors and watch it to the last lingering ray. It was a gratification to him to find a sympathizing admirer; long after he ceased, from failing memory, to name the 'cirrus' or 'cumulus,' he would derive a mental feast from the gaze, and seem to recognize old friends in their outlines.'" He was one of the original Members of this Society, having been elected 1850, May 7.

It will be noticed that, in addition to Members recently elected, who have compounded, several of the old annual Members have since compounded, making an addition, after withdrawing the name of one Member deceased, of twenty-two Life Members.

THE PROCEEDINGS.—The Eighth Number, containing the Annual Report for 1862–63, completed the First Volume of the 'Proceedings,' and was published as soon as possible after the General Annual Meeting in June 1863. Besides the Table of Contents, two Indices were prepared, and printed. One is an "Index of Names of Persons," prepared by the Editor, and containing every person's name that appears in any page of the Volume, and a reference to every page in which the name appears. The other is an "Index of Subjects," for which the Editor is indebted to the kindness of Mr. Alexander John Cuming, a new Member who was elected at the last Annual Meeting. A cover was prepared by the Society for Vol. I.

The subsequent publications of the 'Proceedings' are—

		Published	Price.
No. 9.	1863, November 18.	1864, January 22.	2*s*. 6*d*.
No. 10.	1864, January 20.	" March 29.	3*s*. 6*d*.
Nos. 11 & 12.	" February 17 and " March 16.	" May 11.	4*s*. 6*d*.

No. 13 is in type, and will be published with No. 14, containing the business of this evening, as a double number.

In the last Report, the price at which the several Numbers of the 'Proceedings' were published was omitted. It will complete the record to supply it in this place:—

		s.	*d*.			*s*.	*d*.
No. 1.	Price	3	0	No. 5.	Price	2	6
" 2.	"	2	0	" 6.	"	2	0
" 3.	"	2	0	" 7.	"	2	0
" 4.	"	2	0	" 8.	"	4	0

The following is a list of the stock of 'Proceedings' now on hand at the Printers':—

No. 1.	0 copies.	No. 7.	81 copies.
" 2.	12 "	" 8.	90 "
" 3.	21 "	" 9.	140 "
" 4.	29 "	" 10.	139 "
" 5.	70 "	" 11 & 12.	147 "
" 6.	89 "	Complete Vol.	25 "

The following Papers have been read at the Ordinary Meetings during the Session 1863–64:—

1863, November 18.

1. "The Inaugural Address" of R. Dundas Thomson, Esq., M.D., F.R.S., President.
2. "On the Gale of October 30, 1863." By James Glaisher, Esq., F.R.S., Secretary.

3. "A Method of Determining the Path of a Meteor." By Alex. Herschel, Esq. Communicated by James Glaisher, Esq., F.R.S., Secretary.
4. "On Meteorites." By Prof. G. Giuseppe Bianconi, of Bologna. Translated and communicated by H. S. Eaton, Esq., M.A., Librarian.
5. "Rain at New Moon." By J. Park Harrison, Esq., M.A.
6. "Vapour-pressure and Vapour-action." By John C. Bloxam, Esq.
7. "Remarks on the Storms of 1863, December 2 and 3." By James Glaisher, Esq., F.R.S., Secretary.
8. "On the Velocity of Propagation, between Oxford and Kew, of Atmospheric Disturbances." By Balfour Stewart, Esq, M.A., F.R.S.
9. "Earthquake Theory." By Charles Griffin, Esq. Communicated by Charles V. Walker, Esq., F.R.S., Secretary.
10. "History of the Earthquake of 1863, October 6." By E. J. Lowe, Esq., F.R.A.S., F.G.S., &c.
11. "Sound in the Upper Air while the Lower Air was still." By Alex. Herschell, Esq. Communicated by Henry Storks Eaton, Esq., M.A., Librarian.
12. "Snow-Crystals and Hail as observed at the Beeston Observatory." By E. J. Lowe, Esq., F.R.A.S., &c.
13. "Ozone Observations in Finland." By E. H. Julin. Communicated by L. P. Casella, Esq.
14. "On the Storms at the close of October 1863." By Henry Storks Eaton, Esq., M.A., Librarian.
15. "Climate of Gangaroowa, near Kandy, Ceylon." By H. H. Harnes, Esq. Communicated by L. P. Casella, Esq.
16. "Computation of the Dew-point from the Readings of the Wet and Dry Thermometers." By J. C. Bloxam, Esq.
17. "Monthly Meteorological Table of Observations, taken at Lagos, Africa, for the Half-year ending December 31st, 1863." By Charles D. Turton, Esq.
18. "Description of a Portable Anemometer of moderate cost." By Mr. Adie. Communicated by H. S. Eaton, Esq.
19. "Movement of the Air from January 31st, 1863, to January 31st, 1864, as recorded at the Beeston Observatory by the 'Atmospheric Recorder.'" By E. J. Lowe, Esq., F.R.A.S. &c.
20. "The Terrific Gale of December 2, 1863. Was it a direct Gale or a Cyclonic (Circular) Storm?" By Lieut.-Col. Henry Austen.
21. "On the Meteorology of England for the Years 1858 to 1862, and the combination of the Results with those of the Years 1855, 1856, and 1857." By James Glaisher, Esq., F.R.S., Secretary.
22. "New Mercurial Barometer and New Mercurial Maximum Thermometer." By James Hicks, Esq. Communicated by H. S. Eaton, Esq.
23. "Record of Rain at Cirencester, Gloucestershire, from 1845 to 1863." By Thomas C. Brewin, Esq. Communicated by James Glaisher, Esq., F.R.S., Secretary.

24. "Notes on his Eighteenth Balloon Ascent." By James Glaisher, Esq., F.R.S., Secretary.
25. "Forecasts of the coming Season." By Lieut.-Col. Henry Austen.
26. "Forecasts of the coming Summer." By T. DuBoulay, Esq.
27. "Explanation of Meteorological Tables, illustrating the Climate of East Tropical Africa." By John Kirk, Esq., M.D. (of Dr. Livingstone's Zambesi Expedition). Communicated by F. Galton, Esq., F.R.S., Foreign Secretary.
28. "Ozone Observations at Elsinore, Finland." By M. E. Julin. Communicated by L. P. Casella, Esq.
29. "Photographic Reproduction of Magnetic Tracings at Kew and at Lisbon." By Balfour Stewart, Esq., M.A., F.R.S.

No change has been made in the arrangement of the Library during the past year; it is tolerably well arranged, though not so well as your Librarian could wish. It is available for consultation by Members, as heretofore, between 11^h A.M. and 4^h P.M., at Mr. Beardmore's Rooms, 30 Great George Street, Westminster; but on Saturdays it is closed at 1 P.M.

Since the last Anniversary, 102 volumes and pamphlets have been added to the shelves, all of them being presentations; and of the total number, 25 volumes were presented by Mr. Balfour Stewart, F.R.S., Director of the Kew Observatory.

In the same interval 63 volumes have been borrowed by 18 Members on various occasions; of which 16 are in the hands of Members at the present date.

Your Librarian, Mr. Eaton, has prepared a fresh Catalogue, in which, for convenience of reference, the titles of the books are condensed as far as practicable.

A copy will be sent to each Member, with this Report.

BENEFACTORS.—The following is a list of the institutions and persons who have contributed to the Library during the present Session; and whose names are here recorded in accordance with Rule 68:—

America	American Government.
"	American Philosophical Society.
"	Regents of the Smithsonian Institution.
England	British Government.
"	Royal Astronomical Society.
"	Royal Institution of Great Britain.
"	Liverpool Philosophical Society.
"	Stonyhurst Observatory, Director of.
France	French Meteorological Society.
Norway	University of Christiania.
Portugal	Royal Academy of Sciences, Lisbon.
Scotland	Scottish Meteorological Society.
Sweden	Royal Swedish Academy of Sciences.

Abbot, Francis.	Lee, Dr.
Armellini, Prof. T.	Main, Rev. R.
Astronomer Royal.	Martins, Chas.
Bianconi, Prof. G. G.	Mello, Don A. Manual de.
Brooke, Charles.	Negretti and Zambra.
Burge, F. L.	Perrey, Alexis.
Döve, Prof.	Petit, M. F.
Du Boulay, Thos.	Secchi, Father.
FitzRoy, Admiral.	Sinobas, Don Manual Rico Y.
Fournet, M. M.	Smith, Augustus.
Fritsch, Karl.	Smyth, Admiral.
Galton, Francis.	Stewart, Balfour.
Glaisher, James.	Symons, G. J.
Graham, Lieut.-Col.	Todd, Charles.
Hartnup, J.	Vernon, G. V.
Heis, Dr. Ed.	Walker, C. V.
Jackson, Dr. Scoresby.	Witherby, R.

The free list remains as before (*vide* vol. i. pp. 403–4), namely, the 'Proceedings' are presented free of cost to forty-eight institutions and individuals.

Your Foreign Secretary, Mr. Galton, reports that Charles Rous Marten, Esq., of Martendale, New Zealand, had applied through our Vice-President, Mr. Silver, that the Council of the Society would, in accordance with the circular issued in June 1863 (*vide* vol. i. pp. 397–400), "forward through one of the Secretaries a simple outfit of the necessary thermometers and rain-gauges, verified and packed for immediate shipment and use." He has made a "prepayment of £2 10*s*. to meet their cost;" and the instruments have been forwarded to him.

Account of the Treasurer of the British Meteorological Society for the year 1863.

Receipts.

Date		£ s. d.	£ s. d.	£ s. d.
1863.				
Jan. 1.	To Balance			47 8 3
	Subscriptions:—			
Feb. 3.	J. R. Croskey, Esq.		10 0 0	
Apr. 11.	Edwin Clark, Esq.		10 0 0	
May 6.	J. Gurney Barclay, Esq.		10 0 0	
Aug. 12.	Rev. F. Silver		10 0 0	
" "	W. Sowerby, Esq.		10 0 0	
" 14.	G. G. G. F. Pigott, Esq.		10 0 0	
Nov. 26.	H. Deane, Esq.		10 0 0	
" "	H. Deane, jun., Esq.		10 0 0	
" 20.	L. P. Casella, Esq.		10 0 0	
Dec. 24.	H. S. Eaton, Esq.		10 0 0	
	Ten Life Subscribers		100 0 0	
Dec. 31.	Subscriptions in arrear	59 0 0	} 204 3 0	
" "	Do. for 1863	133 3 0		
" "	Do. for 1864	12 0 0		
Nov. 13.	Dividend on £450 New 3 per Cents, April	6 10 0	} 13 15 8	
" "	Do. £500 do. Oct.	7 5 8		
June 15.	Sales of 'Proceedings,' &c.	6 19 8	} 17 16 5	
Sept. 19.	Do. do.	10 16 9		
Dec. 31.	Total *Receipts*			335 15 1
				£383 3 4
1864.				
Jan. 1.	To Balance in favour of British Meteorological Society			47 15 4

Examined and found correct,
CHARLES GREAVES, *Auditor.*

Expenditure.

Date		£ s. d.	£ s. d.	£ s. d.
1863.				
May 20.	By Printing 350 Balloting List	1 5 0		
June 26.	Do. 500 Notes of Council Meetings	0 18 6		
" 16.	Instructions for Observers	1 3 8		
" "	Miscellaneous	0 10 0		
" "	Proceedings, No. 6... £28 6 6	} 27 7 6		
" "	Less, for Advertisements 0 19 0			
" "	Proceedings, No. 7... 16 2 0	} 15 18 6		
" "	Less, for Advertisements 0 3 6			
Sept. 19.	Proceedings, No. 8 ...... Less, for Advertisements	31 12 4		
" "	Institutes	7 7 6		
" "	Prospectus, Instructions, &c.	2 10 0		
June 30.	Registrar-General's Reports	2 17 0		
Dec. 31.	Do.	2 16 0		
			94 6 0	
June 30.	Binding Books and Manuscripts	7 3 10	} 8 15 11	
Sept. 19.	Do.	1 12 1		
" 21.	Distribution of Reports, &c.		4 8 3	
June 30.	Postage Stamps	8 0 10	} 12 14 6	
Dec. 31.	Do.	4 13 8		
" "	Stationery		3 11 0	
" "	Do. and Postage, Secretary Walker	1 12 3	} 7 3 3	
" "	Do. Do., &c., Librarian Eaton	5 11 0		
" "	Collector's percentage		7 2 0	
" "	Attendance, Tea, &c., in Great George Street		7 9 7	
" "	Assistant to Secretary Glaisher		52 0 0	
	Total *Disbursements*		197 10 6	
June 30.	£50 New 3 per Cents, at 93⅝	46 16 3		
Oct. 28.	Do. do., at 91½	45 15 0		
Nov. 18.	Do. do. (ex. div.) 90⅝	45 6 3		
	Investment of Life Subscriptions		137 17 6	
Dec. 31.	Balance at Banker's	41 10 5	} 47 15 4	
"	Do. Treasurer's	6 4 11		
			£383 3 4	

HENRY PERIGAL, Jun., *Treasurer.*

The Report having been read, the following resolutions were carried unanimously:—

Proposed by Alex. Beattie, Esq., J.P.,
Seconded by S. M. Drach, Esq., F.R.A.S.

That the Report, which has just been read, be received and adopted; and that it be printed and circulated among the Members of the Society.

Proposed by C. V. Walker, Esq., F.R.S., F.R.A.S.,
Seconded by A. Brewin, Esq.

That this Meeting is of opinion that to be Incorporated by Royal Charter would advance the interests and increase the usefulness of this Society.

Proposed by Augustus Smith, Esq., M.P.,
Seconded by W. Hering, Esq., M.D.

That the Council be requested to take the steps necessary for obtaining a Royal Charter of Incorporation.

Proposed by James Glaisher, Esq., F.R.S., F.R.A.S.,
Seconded by C. Brooke, Esq., M.A., F.R.S.

That, in the event of a Charter being granted by the Crown, the Society be Incorporated under the style and title of "The Meteorological Society;" and that the Members use the distinctive letters "F.M.S."

Proposed by A. Brady, Esq., F.R.G.S.,
Seconded by A. Smith, Esq., M.P.

That a private subscription be opened for meeting the expense connected with procuring a Charter; and that the Secretaries issue circulars for that purpose.

Proposed by H. S. Eaton, Esq., M.A.,
Seconded by Jas. Glaisher, Esq., F.R.S., F.R.A.S.

That the cordial thanks of the British Meteorological Society be communicated to the Council of the Institution of Civil Engineers for having granted the Society free permission to hold their Meetings in the rooms of the Institution during the Session that has just ended.

The President appointed W. F. Ingelow, Esq., and A. Brewin, Esq., as Scrutineers; and a ballot was then taken, and the following list of Members, prepared and proposed by the retiring Council, was received and adopted as Council and Officers for the sixteenth Session, 1864–65:—

THE OFFICERS AND COUNCIL

OF

THE BRITISH METEOROLOGICAL SOCIETY,

ELECTED 15TH OF JUNE, 1864.

President.

ROBERT DUNDAS THOMSON, ESQ., M.D., F.R.S. L. & E., 41 *York Terrace, Regent's Park*, N.W.

Vice-Presidents.

ANTONIO BRADY, ESQ., F.G.S.
S. W. SILVER, ESQ., F.R.G.S.
J. W. TRIPE, ESQ., M.D.
S. C. WHITBREAD, ESQ., F.R.S., F.R.A.S.

Treasurer.

HENRY PERIGAL, ESQ., F.R.A.S., 57 *Warren Street, Fitzroy Square*, W.

Secretaries.

J. GLAISHER, ESQ., F.R.S., F.R.A.S., *Dartmouth Place, Blackheath*, S.E.
C. V. WALKER, ESQ., F.R.S., F.R.A.S., *Fernside, Red Hill, Reigate*.

Foreign Secretary.

LIEUT.-COL. ALEX. STRANGE, F.R.S., F.R.A.S., 16 *Ovington Square, Brompton*, S.W.

Librarian.

H. S. EATON, ESQ., M.A., 25 *Great George Street*, S.W.

Council.

N. BEARDMORE, ESQ., C.E., F.R.A.S., F.R.G.S., F.G.S., &c.
C. BROOKE, ESQ., M.A., F.R.S.
LATIMER CLARK, ESQ., C.E.
W. P. DYMOND, ESQ.
F. GALTON, ESQ., M.A., F.R.S., F.R.G.S.
J. P. HARRISON, ESQ., M.A.
J. LEE, ESQ., LL.D., F.R.S., F.R.A.S., F.L.S., F.G.S., F.S.A.
R. W. MYLNE, ESQ., C.E., F.R.S., F.G.S., F.S.A.
D. SLATE, ESQ.
T. SOPWITH, ESQ., M.A., F.R.S., F.G.S.
BALFOUR STEWART, ESQ., M.A., F.R.S.
G. J. SYMONS, ESQ.

The following Resolutions were carried unanimously:—

Proposed by W. Camps, Esq., M.D., F.S.S.,
Seconded by S. M. Drach, Esq., F.R.A.S.

That the thanks of the Society be given to the Officers for their services during the Session that has now closed.

Proposed by S. W. Silver, Esq., F.R.G.S.,
Seconded by W. Hering, Esq., M.D.

That the thanks of this Meeting be given to Dr. Tripe, Vice-President, for the courteous manner in which he has conducted the business of this Meeting.

Proposed by Augustus Smith, Esq., M.P.,
Seconded by Louis P. Casella, Esq., F.R.A.S.

That the special thanks of this Society be given to Mr. Walker for the energy, perseverance, and success with which, as Editor, he has conducted the 'Proceedings of the British Meteorological Society.'

NOTICE.

Session 1864–65.

The Meetings will be held on the Third Wednesdays in the month,

at 25 Great George Street, Westminster, S.W.,

by the kind permission of

The Council of the Institution of Civil Engineers.

Ordinary Meetings at 7 p.m.

1864.	November	16	1865.	March	15
1865.	January	18	„	April	19
„	February	15	„	June	21

The Annual General Meeting will be held after the Ordinary Meeting on June 21.

Council Meetings.

1864.	October	19	1865.	March	15
„	November	16	„	April	19
1865.	January	18	„	June	21
„	February	15	„	October	18

***** After the Meeting a Subscription List was opened in the room, to meet the expenses of procuring a Royal Charter; and £54 0s. 6d. was subscribed.**

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

VOL. II. 1864, NOVEMBER 16. [No. 15.

S. C. WHITBREAD, Esq., F.R.S., Vice-President, in the Chair.

Capt. F. J. Bolton, 12th Regiment, Berkeley Chambers, Bruton Street, S.W.;
W. M. Burke, Esq., M.D., 31 Molesworth Street, Dublin;
Henry Farmer, Esq., Flora Cottage, Lenton, near Nottingham;
D. A. Freeman, Esq., 1 Pump Court, Temple;
A. Henriquez, Esq.,
James Hicks, Esq., Hatton Garden;
Thomas Letts, Esq., Perry Hills, Sydenham, and Black Gang, Isle of Wight;
Colonel W. Myers, H. P. Royal Staff Corps, Halifax, Nova Scotia;
Thomas E. Wyatt, Esq., Spring Grove, W.;
were balloted for and duly elected Members of the Society.

The names of Two Candidates for admission into the Society were read.

LXXII. *On the Relation of the Atmospheric Air to the Aqueous Vapour existing therein.* By Professor LAMONT.

[Translated by W. T. Lynn, Esq., B.A., F.R.A.S., of the Royal Observatory, Greenwich.]

AFTER I had furnished, in the year 1857, the first proof that the aqueous vapour existing in the atmospheric air does not, as it was

generally supposed to do in conformity with Dalton's laws, form an atmosphere independent of the air, and subsisting by itself *, I succeeded, in the year 1862, in proving, by an unequivocal experiment, that Dalton's law itself needs a correction, and that the vapour, when it exists in a space full of air, is not independent of the air, but rather the air and the vapour mutually exercise a pressure upon each other †. I now return to the same subject, partly in order to remove misunderstandings, partly in order to discuss more accurately some individual points in the vapour-theory itself.

As regards the misunderstandings, some persons appear to have doubted whether the doctrine of the independent nature of the vapour-atmosphere was really started by Dalton and has been accepted by meteorologists, whilst others have considered it to be of little importance, in meteorological investigations, whether the existence of an independent vapour-atmosphere be assumed, or the vapour be regarded as merely mixed with the air.

What views Dalton held concerning the constitution of the atmosphere are found so clearly and definitely expressed in his writings that no doubt thereupon can arise. His doctrine is, that, if several gases exist in the same space, each gas exerts a pressure upon its own molecules only, and each gas diffuses itself as if the other gases were not present at all. He therefore distinguishes five different atmospheres as existing upon the earth's surface, each of which is wholly independent of the others—namely, the nitrogen atmosphere, the oxygen atmosphere, the vapour atmosphere, the carbonic-acid atmosphere, and the hydrogen atmosphere. He adds moreover that, if one or other atmosphere were suddenly withdrawn, this would have not the slightest effect upon the distribution and diffusion of the rest ‡.

* Memoirs of the Mathematico-physical Class of the Royal Academy of Sciences, viii. p. 183.

† Extract from a letter to Prof. Kämtz, dated Munich, 1862 (Proceedings of the Brit. Meteor. Soc. i. p. 310).

‡ Dalton considers, first, the different hypotheses which could be held upon the mixture of gases with regard to the relation of the individual ingredients, and comes to the conclusion that only perfect independence can satisfy the observed facts; he then continues, "Before the modern discoveries in chemistry, the atmosphere was considered as one simple elastic fluid sui generis. Lavoisier taught us there were two essentially distinguishable fluids to be found in it. . . . it now appears there are at least four distinct elastic fluids found in every portion of atmospheric air subject to examination. And these, for aught that appears, are totally independent one of another—so much so, that, if any one of them was wholly withdrawn from the surface of the earth, the rest would not at all be affected by

In books on physics we find the same principles repeated, and it is not known to me that since Dalton's time any physicist of note has attempted to contradict them. The same may be said of meteorologists, whose views have been very fully developed and collected by Schmid*.

Now the experiment instituted by me proves incontestably that, if air and aqueous vapour exist in the same space, the vapour exerts a pressure upon the air, and the air upon the vapour; and consequently the proposition upon which Dalton started, and the conclusions which he deduced from it, are perfectly untenable. Mr. Bloxam indeed asserts† that, notwithstanding the facts which have been brought forward, Dalton's laws, "as they have been accepted by British meteorologists," must be looked upon as perfectly correct. Meantime I find that Sir J. Herschel, in his "Meteorology," expressly enunciates as a principle the mutually independent nature of the vapour and the air‡ ("non-reciprocity of pressure"); I find moreover that the first British meteorologists now living subtract the vapour-pressure from the observed reading of the barometer with the view of obtaining the pressure of dry air—a practice which has no meaning unless the existence of an independent vapour atmosphere be assumed.

How far it can be the same in meteorological inquiries, whether we regard the pressure of vapour as independent or the vapour as mixed with the atmosphere, becomes clear, if we consider that in the first case no atmospheric motion is produced by the former,

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the circumstance, either in their density or situation; or if any atmosphere of another kind were added to them, they would still retain their respective stations and densities." (Mem. of the Lit. and Phil. Soc. of Manchester, vol. v. pt. ii. p. 545.)

* Universal Encyclopædia of Physics, "Meteorology," by Schmid, pp. 42, 601, 920.

† Proceedings of the British Meteorological Society, vol. ii. p. 44. Compare also an earlier paper of the same author, vol. i. p. 362.

In the same volume, the doctrine according to which, in contradiction to Dalton's theory, the vapour is scattered in the atmosphere without regular distribution, is stated to be derived from Halley; more justly, however, it might be ascribed to Aristotle. Herein, of course, it cannot be overlooked that before Dalton's time the properties of vapour were not known; consequently there cou'd be no such thing as a correct doctrine regarding its relation to atmospheric air. Also more recently it may happen that meteorological writers have occasionally expressed correct opinions in reference to the diffusion of the vapour in the atmosphere, not as adducing such views for the purpose of deciding the scientific questions with which they are connected, but because the writers were themselves wholly unacquainted with those scientific questions and their signification.

‡ "Meteorology," from the 'Encyclopædia Britannica,' by Sir J. Herschel, p. 50.

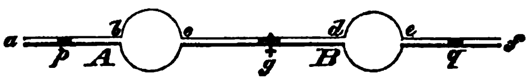
but only the transport of moisture, and in some measure also of heat, whilst in the second case the vapour elevates the atmosphere, moves masses of air from their place, and thereby every change in the vapour produces a corresponding change in the equilibrium of the atmosphere.

I will now discuss more accurately some points in the vapour-theory itself. In the first place it should be remarked that Dalton, when led by his experiments to consider every gas as independent by itself, and not subjected to the pressure of the rest, first conceived this effect to exist in the mixture of permanent gases, and afterwards transferred this effect to aqueous vapour also.

But now, Dalton's previous assumption having been proved to be unfounded in the case of aqueous vapour, it may be asked whether it can be considered as well founded in that of the permanent gases.

There would be no difficulty in deciding this by an experiment*. I have not, however, performed the experiment itself, because the

* Amongst the different contrivances which could be formed to make the experiment, the following appears to me to offer the least difficulty in its execution: Take a glass vessel, of the form represented in the figure, consisting of two spheres,



A and B, and the open narrow tubes, $a\,b$, $c\,d$, $e\,f$, which proceed from them. At first let the communication between A and B be stopped by the cock g, and fill the half $a\,g$ with oxygen gas, the half $g\,f$ with hydrogen, enclosing them by the drops of quicksilver, p and q, upon which the atmosphere presses from without.

Now after, under such conditions, equilibrium has established itself, open suddenly the cock g, and the oxygen of the space A will effuse itself, according to Dalton's theory, without exercising any pressure whatever upon the hydrogen, through the narrow tube $g\,d$ into the space B, and then through the narrow tube $e\,f$ against the drop of quicksilver q; and as this motion, on account of the friction, demands some time, the drop of quicksilver, p, must in the mean time advance further towards A; for an analogous reason the drop of quicksilver, q, will also advance towards B. Not till the oxygen has arrived at the drop q, and the hydrogen to the drop p, will the drops be pressed back to their original positions. A further consequence of Dalton's law would be, that, if the cock were kept open until complete equalization took place, in different parts of the space pressures of different strength would exist.

If the above experiment should be performed, there is no doubt that at the opening of the cocks the drops of quicksilver would remain at perfect rest—a result which, upon the supposition of the independence of the gases, could only be explained if the expansion occupied no appreciable time. Such a supposition Dalton never made, and it would also be contradictory to the laws of the motion of fluids.

result may be foreseen, and would doubtless lead, contrary to Dalton's supposition, to the general proposition, that as there is but one attractive force, which is a property of all ponderable substances in different degrees, so also there exists only one repulsive force amongst the permanent as well as non-permanent gases, which acts upon the molecules in a determinate proportion *. A molecule of oxygen, of hydrogen, of vapour, &c., would, in conformity with this principle, quite independently of their otherwise dissimilar natures, exercise one upon another a mutual repulsion, just as a mass of iron, of stone, of water, &c., would mutually attract one another. The repulsive force of gases must be looked upon as a proper effect of heat.

With regard, moreover, to Dalton's doctrine, it must not be forgotten that he made no experiment by which to prove the independence of the gases, but assumed this independence in order to explain the circumstance which *was* known by experiment, that, if several gases exist in the same space, a uniform mixing takes place, *i. e.* each gas diffuses itself uniformly throughout the whole space. But, on the other hand, it should be remembered that the same effect might arise from a totally different cause; and, as a proof of this assertion, the diffusion of colouring-matter in water may serve as an example. If appropriate colouring-matter be introduced into a vessel filled with water, its atoms will immediately begin to scatter themselves, and, after a longer or shorter time, the colouring-matter will be found uniformly distributed through the whole mass of water, although it is not possible to suppose conditions such as Dalton supposed in the uniform distribution of gases. The explanation of the process here considered offers a little difficulty, and different opinions may exist with reference to it. I, for my part, represent to myself the diffusion as a tendency of the molecules of a fluid to enclose molecules of an extraneous nature, and found this view, in the first place, upon the action of the air.

If a magnet be caused to vibrate, a stratum of air of the thickness of three Paris lines will firmly connect itself with the surface of the magnet, partaking in its vibration †; analogously with this,

* This hypothesis has already been discussed by Dalton in the above-mentioned memoir, p. 541; according to his view, however, it must be regarded as irreconcileable with the results of observation.

† Poggendorff, 'Annals,' lxxi. p. 124. Bessel had already, in the year 1827, determined the influence of the adhesion of air in pendulum-experiments; and before him Bezout had laid down correct principles on the same subject.

every atom which moves in the air is surrounded by a spherical, firmly-adhering atmosphere of air, which descends with the atom towards the earth, retarding or sometimes altogether destroying the motion of the atom*.

The supposition of an analogous tendency in gases would suffice to make intelligible their uniform admixture; and although other natural hypotheses also (for example, the assumption that amongst the molecules of the same gas the repulsive force is somewhat greater than amongst the molecules of different gases) might be formed in order wholly or partly to explain the result, it appears to me that there is no sufficient *à priori* ground for the introduction of such hypotheses.

With the principles hitherto established, I will now proceed to discuss somewhat more closely the nature and properties of vapour.

A molecule of vapour consists of water and latent heat united with one another in a proportion quite definite, so that one molecule of vapour has precisely the same quantity of water and of latent heat as another; from this it immediately results that the content of water, as also the latent quantity of heat of a mass of vapour, is proportional to the density of the vapour†.

* I believe that the motion of finely-divided matters in the air has hitherto been usually considered as an effect of the resistance or the tenacity of the air. According to this, a molecule existing in the air would have, in falling, to separate the molecules of air. But the explanation given above appears to me more correct, according to which the slow fall of a molecule arises chiefly from its having to carry with it a certain mass of air; of course, on this supposition, the tenacity of the air acts so much the more strongly. The slow fall of finely divided chalk in water may be mentioned as very appropriate for the elucidation of the effect here spoken of. The particles of chalk, which are two and a half times as specifically heavy as water, may remain whole days moving in the water without perceptibly approaching the bottom of the vessel.

The movement of the clouds in the air is to be considered as an analogous process. If a cloud descends towards the earth's surface, the whole mass of air existing amongst the molecules of water must be carried with it; that is to say, a cloud forms a connected conglomerate of air and water, which is only a little specifically heavier than the atmosphere.

Sir J. Herschel ('Meteorology,' p. 101) expresses the opinion that the clouds, without an upward-acting force (which, according to him, chiefly arises from the evaporation produced by the sun's rays), would necessarily fall tolerably quickly towards the earth, and that the clouds, in consequence of this, are higher during the day, and sink lower during the night; this view appears to me to correspond less with the facts determined by observation than the one developed above.

That water can support itself floating, finely distributed, in the air, under certain circumstances, without falling down towards the earth, is proved by the mist which may often be observed when the air is so still as to be without any perceptible motion, and by the vapour which is constantly found in damp cellars.

† With the experiments of Watt, and the more recently obtained results of

As regards the union of the latent heat with the water, we know nothing of its peculiar nature; thus much only is known, that it does not take place by a gradual transition, but, as is generally the case with changes in a state of aggregation, by a sudden change—a spring.

In what the latent condition of the heat consists is also really unknown, although in reference to it several points are determined by observation. In the first place, it results incontestably from a close consideration of all the circumstances, that it is not a sort of affinity or mutual attraction between the water and the heat that produces the formation of the vapour and the latent state of the heat, but that rather the repulsion which the free heat exerts upon itself occasions the transition into the latent condition.

But the latent condition is not a sort of condition of annihilation of power, but a condition of oppression, in which the latent heat is held down by the free heat, the former being immediately converted into free heat as soon as the existing free heat is no longer sufficient to hold it down.

By this it appears that there is between the free and the latent heat a proportion-limit, or, if you will, a state of slippery equilibrium, and that, as soon as the free heat is too great, a part of it must pass into the latent state, and as soon as the latent heat is too great, a part of it must pass into the free state. In this proportion-limit the free, like the latent heat, is to be measured by its quantity.

Now the quantity of free heat in a space is represented by the product of the temperature, read off by the thermometer, into the space, and the quantity of latent heat by the product of the density of the latent heat (that is, of the density of the vapour) into the space; we may therefore substitute for the proportion-limit between the free and the latent heat a proportion-limit of the same significance between the temperature and the density of the vapour.

The principles hitherto developed correspond perfectly to the determinations which observation has furnished in regard to the

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Pambour, this agrees; the more accurate investigations, however, of Regnault show that, in higher temperatures, a gradual deviation from the simple proportion takes place. Nevertheless we may make the simple proportion the foundation of a theory of vapour, just as, in investigations concerning the laws of elastic bodies, we have to proceed from the simple relation of perfect elasticity, although it does not actually exist in nature.

origin and circumstances of vapour existing in space void of air, and in particular explain how, in continued compression of vapour or continued diminution of temperature, a limit is reached at which the molecules of vapour begin to resolve themselves into their constituent parts—water and heat.

In space full of air, some modification takes place in the formation as well as in the condition of the vapour. The *formation* of the vapour is not, indeed, restrained by the pressure of the air; for the union of the heat with the molecules of water goes on quite independently of every pressure; but the air opposes hindrances to the *diffusion* of the vapour; and as new vapour cannot be formed until that hitherto formed has removed itself from the surface of the water, the formation of the vapour is retarded: in other respects the vapour spreads itself, by virtue of the above-explained diffusion-tendency, uniformly with the time into every part of the space enclosed.

In space filled with air, the vapour has to resist, besides its own pressure, the pressure of the air also; and in consequence of this every individual molecule of vapour is compressed, and (if the molecules of vapour are considered as elastic spheres) pressed into a smaller volume: since, however, the molecules of vapour are hereby uniformly distributed, and their centres remain as far distant from one another as if no air at all were present, the density of the vapour is neither increased nor diminished, and therefore the above-stated proportion-limit between the temperature and density is not changed. The vapour, as a constituent part of a mixture of several gases, produces then an augmentation of the pressure equal to the pressure which it would have exerted of itself in space void of air; and also the proportion-limit between the temperature and the density suffers no change from the pressure of the other gases,—everything in agreement with the result deduced by Dalton from his experiments, that with vapour it makes no difference in respect to pressure, any more than in degree of saturation, whether the vapour is in space full or void of air.

So long as we experiment with aqueous vapour under a glass bell, these propositions remain perfectly true; but if they are tried in the infinitely-extended space of the atmosphere, there enters into consideration—

1. That upon the earth's surface not only the water but also the free heat is very unequally distributed, and therefore the formation of vapour takes place in a manner by no means uniform.

2. That, from the great extent of the atmosphere, a uniform distribution of the vapour therein, even if no peculiar hindrances existed, could only be brought about after the lapse of a long period of time*.

3. That many peculiar hindrances oppose that uniform distribution, amongst which the general ones should be principally mentioned, such as the local currents of air, the continual changes of temperature, and partial condensation.

The distribution of the aqueous vapour in the air is dependent upon an infinite number of effective causes, of which each alone would produce a certain uniform final condition, but which follow so quickly upon one another that a final condition is never reached. Even the principal causes upon which the existence of vapour depends act only in feeble proportion. Thus the quantity of vapour should gradually diminish from the equator towards the poles, and the density of the vapour should diminish in uniform proportion with the elevation; the nature, nevertheless, of the earth's surface (tracts of water and land) and the currents of the atmosphere (carrying in horizontal strata across one another warm and damp streams from the south, cold and dry from the north) modify these results to a very great degree, and even sometimes completely reverse the normal relations. In the latter respect the vapour possesses a very great analogy with the temperature of the air; and this analogy serves also as the best model for proceeding in deciding how the meteorological investigation of the aqueous vapour contained in the air should be conducted.

We determine the temperature on the surface of the earth, its mean values, daily and annual periods; the same must be done with the vapour, and it is the density of the vapour which should be taken to determine the mass, so much the more as the density is indicated by the instruments employed in the measurement. As the temperature which is observed on the earth's surface affords no clue for the investigation of the temperature in the higher regions of the atmosphere, so also from the quantity of vapour

* In the atmospheric air, even the perfectly uniform distribution of the constituent gases is to be ascribed to the continued process of admixture during thousands of years. The opinion that in the higher regions, on account of the difference of specific gravity, relations of mixture must subsist different from those which are found upon the earth's surface has not been confirmed by experience, and would never have been theoretically started if proper regard had been paid to the constant interchange of the upper and lower strata of air, and to the tenacity of the air.

existing at the earth's surface no correct conclusion can be drawn concerning the quantity existing in elevated regions.

The progressive diminution of temperature with elevation forms an investigation which can only lead to certain mean values by numerous series of observations made at different seasons of the year and at different parts of the earth's surface; precisely in the same manner, and not by any assumption of a theoretically-correct but never actually-subsisting diffusion (or, if you will, expansion) of the vapour, will it be possible to arrive at a knowledge of the proportion of aqueous vapour contained in the atmosphere at different elevations.

LXXIII. *On the Aurora Australis of 8th June* 1864. By F. Abbott, Esq., of Hobart Town.

Private Observatory, Hobart Town,
13th June, 1864.

At 8 hours P.M. a distinguished feature of a rich and rare aurora appeared, commencing in the horizon about 20° E.S.E., forming an angle of about 20° to the equator, at which point it took a path bordering on the equator nearly due east and west. At 8^h 20^m it formed an inverted cone, with the apex, apparently $1\frac{1}{2}°$ wide, pointing to the horizon, and the base about $8\frac{1}{2}°$ wide with an altitude of 60°. At this period it became very peculiar in its external properties, forming a large column, of a clear silvery lustre, destined to span the heavens in one entire arch. Its progress in this form became steady and regular, but slow, until it reached the meridian, when it commenced to form another inverted cone, with the apex pointing due west. At about 8^h 40^m it became a most superb object: the brightness of its white light was so excessive as to drown the Via Lactea, and its form a double cone, each cone with a double curve, best described as resembling the form of the diatom *Gyrosigma elongatum* under the microscope, the aurora having a dark line, as in the Navicula, running along its centre, in diameter about $5\pm'$. At 8^h 45^m the aurora-band reached from α Capricornus to α Leo, passing over a portion of Sagittarius, Scorpius, Libra, Virgo, and Jupiter, to Leo, the stars in each constellation being distinctly seen.

On the apex of each cone reaching the two extreme points, they both, as of one accord, began simultaneously and gradually to disappear, and, by a slow process, the cones receded, with a flut-

tering and rolling motion, arriving at the base nearly together. At about 8^h 55^m the whole had vanished from sight.

On the same evening, and during the time of the above phenomenon, a very strong aurora, or southern light, illuminated the horizon for a space of 20° on each side of the pole; but it was quite distinct from, and had no apparent connexion with, the very peculiar and interesting band that formed a path along the zodiac.

The meteorological state of the atmosphere at the time was humid. Rain fell on seven out of the first eight days in June, but the sky was clear and almost cloudless during the aurora.

Atmospheric pressure, 29·681 in. Temperature, 45°.

F. Abbott.

LXXIV. *Observation on a Luminous Meteor observed at Hobart Town.* By F. Abbott, Esq.

Mr. Abbott observed a meteor on June 16, 1864, at 10^h 25^m p.m. It was a globe twice the size of Jupiter, of a rich blue. It neither left train nor sparks: lasted about two seconds. Its direction was from α Ophiuchi to about 10° north of α Lyræ. On exploding, the meteor sent out two flashes of lightning, both flashes of the same colour as the meteor, and in a direction on each side at right angles to its course; each flash in extent about 25°, and one second between each flash.

LXXV. *On Lind's Anemometer.*
By Arthur Forbes, Esq., of Culloden.

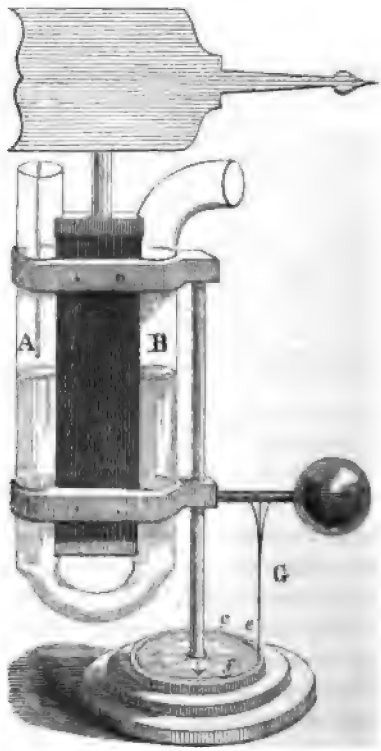
Lind's anemometer being such a simple instrument, and, at the same time, so correct in principle and moderate in price, I have long considered it a subject of regret that no plan has been devised to make it a self-recording anemometer. Several arrangements have occurred to me; but, without at all changing the usual form of the instrument, the following method (so far as I have had an opportunity of trying it) I have found to answer the purpose.

Into the tube, A (fig. 15), is inserted a very narrow slip of strong stiff cardboard, previously steeped in a strong solution of sulphate of iron, the water in the tube having been first impregnated with a few drops of prussiate of potash. On the water being depressed

by the wind in the tube B, it of course ascends in the tube A, in the usual way; but, in doing so, it wets the cardboard, and by the chemical action which immediately takes place between the solution of sulphate of iron on it and the prussiate of potash in the water the cardboard at once changes colour, and assumes a deep blue tint so far as it has been wetted, retaining the colour for any length of time, and thus recording the height to which the water has been driven up by the wind, as read off from the scales.

When the cardboard is of sufficient thickness, I have found that all capillary action is overcome, and that the end of the discoloration is a correct register of the height to which the water has risen in the tube. Of course, in reference to the results, a certain amount of correction may be required for slight displacement of the water in the tube by the presence of the cardboard, and also for change of specific gravity in the water used by the introduction of the small quantity of prussiate of potash; but in large enough tubes the amount of correction required must be very small.

Fig. 15.



The chance of capillary action on the cardboard can be still further overcome by stringing it in small round pieces on a thin, fine needle, and then inserting into the tube A.

I have also contrived the following method by which this anemometer can be made to register the direction of the wind, and the points of the compass through which it has blown for a given time.

Round the brass plate, with the cardinal points of the compass engraved on it, is cut a groove, C, in which are fixed two indexes, E and F, that are pushed to the right or to the left by a pencil-

pointer (as it is termed), G, by the action of the vane, which moves along the groove, carrying an index along with it, and leaving it at the furthest limit to which it has traversed, thus recording the number of degrees of the circle through which the vane has moved, and the points from which the wind has blown since the indexes were set on each side of the pointer, G.

ARTHUR FORBES.

LXXVI. *Some Remarks on the Ten-year Period of the Magnetic Variation and of the Solar Spots.* By Dr. J. LAMONT.

[Translated by W. T. Lynn, Esq., B.A., F.R.A.S., of the Royal Observatory, Greenwich.]

IF the daily motion of the magnetic needle has its cause in a direct influence of the sun, a sort of electric ebb and flow produced by the sun, and the ten-year period arises from the influence of the sun becoming gradually greater and smaller, the magnitude of the daily motion must, for all points of the earth's surface, vary in the same proportion; that is to say, if the daily motion in the nth year at one place is expressed by a_n, and at another place by a'_n, we must have

$$\frac{a'_n}{a_n} = \text{a constant};$$

and if the variation of the motion is produced by an independently existing cosmical force, and not by a modification of the solar influence, we have

$$\frac{a'_n - a'}{a_n - a} = \text{a constant},$$

where a' and a represent the mean motion; but if the ten-year period arises from a modification of forces seated in the interior of the earth, no constant relation of the kind mentioned can well subsist.

I have put together the few determinations which hitherto exist, appropriate for the decision of the question thus raised, and obtained the following two Tables, to which I have added those made at Munich in the corresponding years, for comparison.

TABLE I.

Year.	Russian Observations.				Munich.
	Petersburg.	Kathe-rinenburg.	Nert-schinsk.	Barnaul.	
1848	′ 9·90	′ 8·95	′ 7·86	′ 8·13	11·20
1849	9·36	9·16*	7·16	7·56	10·64
1850	9·82	8·70	7·32	6·08	10·42
1851	7·83	8·08	6·06	5·26	8·71
1852	7·85	7·53*	5·66	5·95	9·00
1853	7·62*	7·79*	6·30	6·03*	8·63
1854	6·55	6·45	4·50	4·86	7·56
1855	6·15	6·40	5·35	5·23	7·33
1856	5·50	5·80	4·50	4·53	7·08
1857	6·19*	6·80	5·23	5·12	7·64

The numbers marked with an asterisk have been newly calculated according to the monthly means.

TABLE II.

Year.	British Observations.			Munich.
	Hobarton.	Toronto.	St. Helena.	
1841	′ 6·12	′ 7·74	′ 2·64	7·86
1842	5·43	6·61	2·74	6·78
1843	5·17	6·25	2·55	6·86
1844	5·39	6·67	2·81	6·34
1845	5·72	6·66	3·08	7·39
1846	6·00	7·11	2·78	8·61
1847	6·34	7·61	3·37	9·38
1848	7·60	8·05	3·48	11·20
1849	7·20	8·49	3·68 (6 M)	10·64
1850	7·39	7·90		10·42
1851	6·13	7·52		8·71
1852	6·74			9·00
1853	6·22			8·63
1854	5·71			7·56

As the magnitude of the daily motion is deduced from two hours only, the disturbances have necessarily a considerable influence, and the above numbers are only to be regarded as a provisional approximation; nevertheless they approach so nearly to the constant proportion denoted above, that, as it appears to me, we have sufficient reason for seeking the cause of the ten-year period in the sun, or at least in a cosmical force acting at a great distance.

In my paper in the second volume of the Report† for 1862, I

† Report of the 'Royal Academy of Sciences' at Munich, the second volume of which for 1864 contains the communication from which this translation has been made.

forgot to mention an important series of observations for the more accurate determination of the length of the period, which Arago made in Paris from 1821 to 1830, and according to which a minimum took place about 1823·3, and a maximum about 1829·0. The turning-points determined with certainty are now as follows:—

Maxima: 1786·5; 1817·0; 1829·0; 1837·5; 1848·8; 1859·5.
Minima: 1823·3; 1843·0; 1855·0.

And if we assume the length of the period to be, as I have determined it, 10·43 years, and start from 1786·5 as initial point, we shall have the following residual errors:—

Maxima: 0·0, +0·4, +1·6, +1·1, −0·3, 0·0.
Minima: −0·3, +0·8, −0·7.

Herr Wolf has, in Poggendorff's 'Annals' (for May 1863), repeatedly asserted that the period should be assumed at 11·11 years, which would leave the following residual errors:—

Maxima: 0·0, +2·8, +1·9, +4·5, −4·4, −4·8.
Minima: −2·0, −4·6, −3·7.

It is evident that it is quite impossible to satisfy the observations by a period of 11·11 years; and this is also the conclusion to which the careful investigation of Mr. Sabine ('Magnetical and Meteorological Observations at St. Helena,' vol. ii. p. 126) has conducted him. With the view of proving that the magnetic period of 10·43 years is inadmissible, Herr Wolf relies upon this, that, according to the London observations, a minimum took place in the year 1796, whereas, if that period was correct, a maximum should then have occurred.

Now Gilpin's observations give the following numbers for the 11 years from 1795 to 1805:—

7′·6, 8′·0, 7′·9, 7′·6, 7′·3, 7′·1, 8′·0, 8′·2, 8′·2, 9′·2, 8′·5, 8′·6.

How, from these numbers, a maximum could be perceived in the year 1796 I cannot, for my part, imagine; they show, in fact, no period at all, which is quite intelligible if we reflect that a needle placed upon a point was employed, the sensitiveness of which was so small that, according to Gilpin's express declaration, the casual deviations might amount to "from 8 to 10 minutes, or even more."

It is interesting to ascertain the grounds upon which Herr Wolf has based his eleven-year period of the solar spots. "The first *certain* maximum," says he, "is that of 1750 (Staudacher), and the first *certain* minimum that of 1755 (Staudacher and Zucconi)

and if we compare these with the maximum of 1860 and the minimum of 1855, we obtain a very consistent period of 11·11 years." The calculation is quite correct; but if we examine Staudacher's observations, we find that in the year 1750 he observed the sun on 31 days only, and in the year 1755 only on one single day; and generally, in the period from 1750 to 1755, the mean number of observations in a year does not quite amount to 25. Again, as to the observations of Zucconi, they include only three years (in four years quite six months are deficient), and they neither give an independent minimum by themselves, nor can they be used to supply the deficiencies of Staudacher's observations*. Now these are what Herr Wolf calls "certain" determinations.

As the case also is similar with the other "certain" data in the last two hundred years, it may easily be foreseen that Herr Wolf, in spite of vehement assertion and confident and oft-repeated publication of his results, will meet with but trifling success. Of the few writers who mention the "eleven-year" period of solar spots, certainly not one has read his publications with attention.

I pass over for the present what might further be said upon this head, and will, in conclusion, add a few remarks upon the stand-point which the investigation of the solar spots at present occupies.

If we take up the tables of Herr Schwabe, we shall find that the regular periodicity of the solar spots is therein expressed throughout in the most determinate manner. Far otherwise is the case if we consider the yearly results of Staudacher, Zucconi, and Flaugergues; for in these there occur, even in the years in which the observations were numerous, sudden changes of so striking a nature that we should be tempted to imagine a complete alteration in the condition of the solar atmosphere, if we did not take into consideration the fact that those observers had neither a determinate method in view, nor proposed to themselves a definite purpose, nor were possessed of sufficient optical assistance. Not until the next twenty years shall have confirmed and augmented the existing foundations, and something more decisive

* That the numbers estimated by different observers may differ even by decades from one another can be proved by more recent data. Former observers appear to have directed their attention principally to the great spots only; and this, amongst other reasons, may explain why, unlike other observers, Flaugergues so frequently found the sun entirely destitute of spots.

shall have been established concerning the possible magnitude of the variations from day to day, and concerning the side of the sun which is turned towards us and turned from us, &c., and thus data be afforded for a discussion of the older observations, can a careful application of these be made of any service to theory; and the immediate combination of the old and new material, without any sifting, can only lead to untenable conclusions.

LXXVII.—*Remarks on the Weather at Culloden in October* 1864. By Arthur Forbes, Esq.

The weather during the first thirteen days of the month was fair and fine, with the barometer high and steady; after this date it became unsettled, and more or less rainy; but between the 18th and 25th a very heavy rainfall took place, as the following note from the register will show:—

Rain-gauge read off at 9 A.M.

	in.
October 19	0·28
" 20	1·85
" 21	0·55
" 22	0·14
" 24	1·52
Total	4·34

—an amount nearly equal to the whole rainfall for the three previous months added together. The direction of the wind, during this unusually heavy rainfall, varied between E.N.E. and N.N.W.; and the force with which it blew, at different times, ranged between 5 lbs. and 15 lbs. on the square foot. The barometer had been keeping low for several days previous to the 19th; its greatest depression occurred at $10^h\ 30^m$ A.M. on the 20th, when the corrected reading, at 104 feet above the sea, was 28·565 inches.

The aurora of the 14th was very beautiful; but it lasted for only a short time, viz. from $6^h\ 30^m$ to $6^h\ 45^m$ P.M. Some of the "streamers" were of a fine crimson colour.

The first snow, on Wevys and other high mountains, did not appear until the 15th.

BOOKS AND NOTICES.

XXIII. *Abstracts of Meteorological Observations made at the Magnetical Observatory, Toronto, Canada West.* In Two Volumes, from the year 1854 to 1862. By the Director, G. T. KINGSTON, M.A.

THE Toronto Magnetic and Meteorological Observatory is situated in the grounds of the University of Toronto, in latitude 43° 39′ 4″ N., longitude 5^h 17^m 33^s W., 108 feet above Lake Ontario, and approximately 342 feet above the level of the sea.

The early history of the Observatory, including the circumstances which led to its establishment by the British Government in 1839–40, are given in detail in the introduction to the First Volume of the Observations, published under the superintendence of General Sabine, R.A., which together with the Second and Third Volumes contain the magnetical and meteorological observations from 1840 to 1848 inclusive.

The *standard barometer* is by Newman. The interior diameter of the tube is 0·6 inch. The corrections for capillarity, amounting only to ·002 inch, have not been applied.

The *standard thermometer* is by Fastré, of Paris, and is graduated *à l'échelle arbitraire.*

All the observations on the temperature of the air were made by this thermometer, excepting when the temperature fell lower than the limits of the scale (about −8°), when the thermometer employed was one supplied from the Kew Observatory.

The *wet-bulb thermometer* is also by Fastré, and is graduated according to an arbitrary scale.

The position occupied by the thermometers till June 24, 1854, was on the outside and near the middle of the north wall of the principal room in the old building. They were protected above by a double projecting roof, and on the east, west, and north by double Venetian shutters, descending to about 4 feet from the ground. The thermometers were attached to horizontal strips of wood, extending east and west, and were read from an aperture in the wall made for that purpose, and fitted with a shutter and sliding window. The bulbs, which were perfectly free, were about 4½ feet from the ground.

On June 24, 1854, the thermometer-shed was removed from the wall, and placed against the south fence of the Observatory enclosure. The thermometers remained under the shed in this position till the completion of the new Observatory. On June 15, 1855, at 3 P.M., they were moved to the new thermometer-shed on the outside of the north wall of the tower. The projecting roof above, and Venetian or rather Louvre shutters of the new shed

The Mean Monthly and Annual Readings of the Barometer in each of the twenty-three years from 1841 to 1863 inclusive, are as follows:—

Years.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1841	29·66	29·49	29·65	29·62	29·55	29·54	29·62	29·70	29·60	29·64	29·57	29·60	29·60
1842	29·51	29·55	29·63	29·56	29·59	29·59	29·66	29·71	29·66	29·64	29·61	29·65	29·61
1843	29·60	29·56	29·56	29·60	29·61	29·55	29·62	29·68	29·69	29·54	29·67	29·67	29·61
1844	29·61	29·66	29·65	29·74	29·55	29·61	29·54	29·53	29·73	29·64	29·61	29·55	29·62
1845	29·62	29·57	29·59	29·60	29·64	29·60	29·51	29·63	29·56	29·79	29·51	29·69	29·61
1846	29·62	29·66	29·60	29·70	29·51	29·59	29·58	29·64	29·62	29·70	29·67	29·64	29·63
1847	29·60	29·62	29·68	29·57	29·58	29·56	29·63	29·64	29·61	29·68	29·69	29·66	29·63
1848	29·67	29·61	29·65	29·73	29·50	29·54	29·57	29·64	29·59	29·60	29·56	29·68	29·62
1849	29·80	29·75	29·71	29·58	29·67	29·62	29·68	29·62	29·68	29·60	29·59	29·68	29·67
1850	29·69	29·49	29·60	29·57	29·56	29·64	29·59	29·60	29·62	29·60	29·66	29·68	29·62
1851	29·61	29·76	29·66	29·60	29·63	29·60	29·55	29·67	29·76	29·60	29·63	29·67	29·64
1852	29·58	29·53	29·59	29·41	29·62	29·52	29·61	29·67	29·70	29·66	29·58	29·60	29·59
1853	29·72	29·59	29·56	29·57	29·60	29·62	29·65	29·59	29·64	29·65	29·79	29·60	29·63
1854	29·61	29·70	29·53	29·64	29·56	29·55	29·64	29·65	29·70	29·70	29·44	29·59	29·61
1855	29·64	29·63	29·51	29·65	29·65	29·51	29·61	29·65	29·72	29·55	29·67	29·70	29·63
1856	29·67	29·49	29·56	29·58	29·58	29·55	29·59	29·52	29·60	29·71	29·64	29·71	29·60
1857	29·74	29·74	29·60	29·53	29·53	29·42	29·59	29·59	29·71	29·67	29·53	29·62	29·61
1858	29·68	29·66	29·62	29·50	29·58	29·60	29·60	29·62	29·65	29·68	29·63	29·70	29·63
1859	29·68	29·64	29·41	29·53	29·66	29·62	29·65	29·60	29·67	29·62	29·68	29·71	29·62
1860	29·65	29·64	29·51	29·58	29·56	29·50	29·56	29·58	29·67	29·67	29·53	29·67	29·59
1861	29·66	29·55	29·62	29·56	29·54	29·57	29·55	29·65	29·61	29·62	29·54	29·75	29·60
1862	29·73	29·61	29·51	29·72	29·59	29·56	29·55	29·61	29·68	29·62	29·64	29·80	29·63
1863	29·65	29·80	29·67	29·64	29·62	29·55	29·59	29·64	29·73	29·70	29·56	29·70	29·65
Means 1841–1863	29·65	29·63	29·59	29·60	29·59	29·57	29·60	29·63	29·66	29·65	29·61	29·66	29·62

are single and painted white, instead of being double and green as in the old shed.

The interior length of the new shed, from east to west, is 13½ feet; the distance of the northern shutter from the northern wall of the Observatory 5 feet; and the height, exclusive of the slope of the roof, 9½ feet. The shutters extend down to a distance of 2 feet from the ground. The thermometers are attached to horizontal strips of wood extending east and west, their bulbs, which are perfectly free, being 4⅛ feet from the ground, and 14 inches from the inside of the shutters. The shed is entered by a door communicating with the interior of the building; but the thermometers can also be read through a window by the aid of a telescope.

Mean Velocity of the Wind in the different Hours.

The maximum velocity is from 1 P.M. to 2 P.M., and the minimum from 1 A.M. to 2 A.M. The maximum occurs in every month during one of the four hours commencing noon, and the minimum in most months within three hours of midnight, a prominent exception being December, when the minimum is at 7 A.M.

Diurnal Distribution of the different Winds with respect to Duration.

1. The durations of the winds from W.S.W. to N.N.W. inclusive, for each hour separately as well as for all hours collectively, are above the average duration of all winds.

2. The durations of winds from E. and E.N.E., taking the twenty-four hours collectively, are above the average; and one or other or both of these winds are above the average at all hours, excepting from 2 A.M. to 3 A.M.

3. The durations of the north winds are above the average for the whole day collectively, and have a marked diurnal period, their duration being above the average duration of all winds from 9 P.M. to 9 A.M., and below the average from 9 A.M. to 9 P.M.

4. The south winds have a duration less than the average, taking one hour with another, and they also have a diurnal period, their durations being above the average duration of all winds from 10 A.M. to 6 P.M., and below the average during the rest of the twenty-four hours.

The principal maximum occurs with the wind from S.S.W. from 11 A.M. to 4 P.M.—that is to say, during a portion of the time when the duration of the south wind is above the average—and it occurs with the N.N.W. and north wind mostly at the hours when the duration of the north wind is above the average; a second maximum, vibrating from E. to E.N.E., during the whole of the day and night. From 9 A.M. to 11 A.M., and from 4 P.M. to 7 P.M., namely when the north and south winds respectively are near their average as compared with other winds, and when the winds in the N.W. quadrant are more equally distributed among its

The following are the mean Monthly and Annual Temperatures of the Air in each of the twenty-three years, from 1841 to 1863 inclusive.

Years.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean Annual Tempe-ratures.	Differences from Average.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1841	25·6	22·4	27·7	39·2	50·5	65·6	65·0	64·4	61·3	41·6	35·0	28·7	43·92	−0·26
1842	27·9	26·9	35·8	43·1	49·1	55·6	64·7	65·7	55·7	45·1	33·3	24·7	43·96	−0·22
1843	28·7	14·5	21·3	40·9	49·1	58·4	64·5	66·4	59·1	41·8	33·5	30·0	42·35	−1·83
1844	20·2	26·0	31·3	47·5	53·6	59·9	66·0	64·3	58·6	43·3	34·9	28·2	44·48	+0·30
1845	26·5	26·0	35·4	42·1	49·6	61·0	66·2	67·9	56·0	46·4	36·8	21·1	44·58	+0·40
1846	26·7	20·4	33·1	44·0	55·5	63·3	68·0	68·4	63·6	44·6	41·3	27·5	46·36	+2·18
1847	23·3	21·5	26·2	39·2	54·4	58·4	68·0	65·1	55·6	44·0	38·6	30·1	43·70	−0·48
1848	28·7	26·6	28·6	41·3	54·1	62·9	65·5	69·2	54·2	46·3	34·5	29·1	45·08	+0·90
1849	18·5	19·5	33·5	39·0	48·0	63·2	68·4	66·3	58·2	45·3	42·6	26·5	44·09	−0·09
1850	29·7	26·0	29·8	37·9	47·6	64·3	68·9	66·8	56·5	45·4	38·8	21·7	44·45	+0·27
1851	25·5	27·6	32·4	41·3	51·3	59·2	65·0	63·6	60·0	47·4	32·9	21·5	43·98	−0·20
1852	18·4	23·4	27·7	38·2	51·4	60·8	66·8	65·9	57·5	48·0	36·0	31·9	43·84	−0·34
1853	22·9	24·2	30·8	41·9	50·8	65·4	65·5	68·7	58·9	44·5	38·7	25·4	44·80	+0·62
1854	23·5	21·2	30·8	41·1	52·1	64·1	72·4	68·1	61·1	49·5	36·9	21·9	45·23	+1·05
1855	25·9	15·6	28·6	42·5	53·0	59·9	67·9	64·1	59·6	45·4	38·6	26·9	43·98	−0·20
1856	16·0	15·8	23·2	42·3	50·4	62·1	69·8	63·6	57·2	45·4	37·4	22·9	42·18	−2·00
1857	12·7	28·7	28·0	35·4	48·8	56·9	67·7	65·4	58·7	45·5	33·6	31·9	42·75	−1·43
1858	30·0	17·1	28·6	41·5	48·8	66·1	67·8	67·7	59·2	48·8	34·2	27·4	44·76	+0·58
1859	26·4	26·2	36·5	39·6	55·1	58·2	66·8	66·7	55·2	43·0	38·9	17·9	44·21	+0·03
1860	23·3	23·0	34·6	39·6	55·5	63·1	63·8	64·5	55·4	47·3	38·0	24·0	44·34	+0·16
1861	19·8	26·2	27·1	42·1	47·4	61·2	65·3	65·5	59·1	48·8	37·2	31·2	44·24	+0·06
1862	21·7	22·6	28·9	39·6	52·1	60·5	66·6	67·7	59·7	48·7	35·6	28·8	44·37	+0·19
1863	28·0	22·6	26·0	42·1	54·2	60·1	67·5	66·6	55·9	46·0	39·1	27·0	44·59	+0·41
Means 1841–1863	23·91	22·78	29·82	40·93	51·41	61·31	66·87	66·20	58·10	45·74	36·80	26·35	44·18	

several points, the easterly or second maximum surpasses in value the westerly or principal maximum.

The west wind during the night is mostly above the twenty-four hours' average, and below the average during several hours of the day; but the range is small, the maximum being to the minimum in the ratio of 1·36 to 1.

The east wind from 8 A.M. to 9 P.M. is above the average of twenty-four hours for that wind, and is below the average from 9 P.M. to 8 A.M., its diurnal range or the ratio of the maximum to the minimum being 2·40 to 1.

The north wind is above the average from 10 P.M. to 9 A.M., and below the average from 9 A.M. to 10 P.M., the range being 3·44 to 1.

The south wind is above the average from 10 A.M. to 7 P.M., and below it from 7 P.M. to 10 A.M., and its range is 4·82 to 1.

Calms occur eight times as often between midnight and 1 A.M. as they do between 1 P.M. and 2 P.M. The hours of maximum and minimum frequency of calms are very nearly the same as the hours of minimum and maximum mean velocity, a correspondence which does not hold in the case of the *annual* distribution of calms.

The *rain-gauge* in use is simply a rectangular vessel, with an aperture of 10 inches by 20 inches, placed 7 feet above the ground, and communicating by a pipe with a receiver beneath. The volume of water received is measured by a glass graduated to cubic inches and parts of an inch.

The frame supporting the rain-gauge stands in the enclosure surrounding the Observatory, and at a distance from other objects sufficient to secure it from the effect of eddy winds.

The monthly average number of days on which rain fell, as given by the six years terminating with 1859, are month for month, with one exception, either equal to or greater than the corresponding monthly averages for the series of fifteen years terminating also with 1859, the excess on the whole year being twelve days in favour of the shorter series. The same remark applies, and without any exception, to the monthly averages of the number of days of snow.

With respect to the *quantity* of rain the case is reversed, the average annual depth in the six-year series being less than that in the fifteen-year series by about 0·6 of an inch; but this deficiency in the amount of rain is in part made up by a greater amount of snow; so that in combining together the rain and snow, the average amount generally of aqueous precipitation in the year differs only by little more than a tenth of an inch in the two series; and this difference would disappear if 8 inches of snow, instead of 10 inches, were taken as equivalent to 1 inch of water.

The following are the ratios showing the Annual Distribution of each Wind, expressed in terms of their respective yearly arithmetic terms.

1853–1862.

	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.
January	1·09	1·12	1·27	0·63	0·63	0·62	0·50	0·50	0·34	0·65	1·41	2·13	1·42	0·90	0·88	0·97
February	1·04	1·06	0·99	0·74	0·80	0·58	0·55	0·57	0·43	0·80	1·15	1·53	1·62	1·21	0·95	0 95
March	0·61	0·50	0·69	1·03	0·94	0·68	0·93	0·52	0·56	0·71	1·11	0·99	1·40	1·62	1·62	0·93
April	1·13	1·18	1·17	1·42	1·61	1·39	1·18	0·97	0·80	0·82	0·65	0·56	0·70	0·94	0·87	1·00
May	1·08	0·85	1·12	1·61	1·50	1·50	1·17	1·17	1·26	1·18	0·57	0·36	0·48	0·73	0·88	1·18
June	0·88	0·65	0·87	1·22	1·27	1·28	1·04	1·14	1·68	1·44	1·05	0·48	0·69	0·69	1·05	0·99
July	0·93	0·93	0·70	0·93	1·01	1·40	1·54	2·12	2·00	1·48	0·76	0·47	0·48	0·74	0·92	1·11
August	1·02	1·16	0·91	0·67	0·90	1·07	1·50	1·39	1·60	1·24	0·80	0·45	0·68	1·02	1·17	1·20
September	1·22	1·19	1·02	0·91	0·89	0·96	1·47	1·43	1·40	1·44	0·91	0·58	0·70	0·85	0·91	0·99
October	1·03	1·09	1·16	1·04	0·90	0·99	0·69	0·91	1·17	1·00	0·97	0·74	1·02	1·33	0·98	0·89
November	0·82	0·91	0·95	1·03	0·96	0·80	0·88	0·82	0·54	0·75	1·27	1·76	1·28	1·04	0·87	0·80
December	1·15	1·37	1·15	0·77	0·58	0·73	0·55	0·45	0·21	0·49	1·35	1·95	1·54	0·93	0·90	0·98

Average Number of Days on which Rain fell, with Depth in inches, for all the Months in the year.

RAIN.

	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Mean for Year.
Number of Days*	5	4	6	9	11	12	10	10	11	12	10	5	106
Amount fallen in inches† ...	1·3	1·0	1·6	2·4	3·1	3·0	3·7	3·0	3·8	2·5	3·2	1·6	30·2

* Mean from years 23. † Mean from years 21.

Average Number of Days on which Snow fell, with Depth in inches, for all the Months in the year.

SNOW.

	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Mean for Year.
Number of Days*	12	12	9	3	0	0	0	0	0	2	6	13	58
Amount fallen in inches† ...	14·3	18·3	9·3	2·4	0·1	....	....	....	....	0·8	3·2	14·5	62·8

* Mean from years 23. † Mean from years 20.

The depth of the rain or snow recorded as having fallen during any day was measured at 9 A.M. of the following day, prior to January 1, 1856; but after that date the time was changed to 6 A.M.

When rain under half an inch is taken alone, the winds of more than an average duration, if we except an interruption that occurs at N.E., are the same as when no account is taken of the amount that fell in the day; the wind of least duration is still from N.W., but that of the greatest duration is no longer so decidedly at E.N.E.

When rains, amounting to less than half an inch, are omitted, the most rainy and least rainy winds are still from E.N.E. and N.W.; but the relative duration of the E.N.E. wind is eighteen times as great as that of the N.W. wind. The winds, also, whose relative durations are above the average are limited to the four points N.N.E., N.E., E.N.E., and East.

The barometer, standard thermometer, and wet-bulb thermometer were read six times each day, namely at 6 A.M., 8 A.M., 2 P.M., 4 P.M., 10 P.M., and midnight, excepting on Sundays, Christmas Day, and Good Friday, when these instruments were read at 6 A.M. and 2 P.M. only. These latter readings, though recorded in the daily registers, are not included in the hourly means for those

Ratios comparing the relative durations of the several winds during days in any part of which rain fell, from observations in the years 1853 to 1859 inclusive—the falls under half an inch in the day, those of half an inch and upwards, and rain generally, without reference to its amount, being considered separately.

Direction of the wind.	Rain under half an inch.	Rain half an inch and upwards.	Rain generally.
N.	0·73	0·64	0·72
N.N.E.	0·76	0·88	0·77
N.E.	1·01	1·40	1 06
E.N.E.	1·41	2·71	1·58
E.	1·36	2·43	1·50
E.S.E.	1·17	1·61	1·23
S.E.	1·06	1·12	1·07
S.S.E.	1·07	1·20	1·09
S.	1·04	0·73	1·00
S.S.W.	1·14	0·88	1·11
S.W.	1·07	0·80	1·03
W.S.W.	0·94	0·30	0·85
W.	0·86	0·34	0·79
W.N.W.	0·80	0·47	0·76
N.W.	0·81	0·43	0·76
N.N.W.	0·77	0·45	0·72
Calms.	1·00	0·62	0·95

Ratios comparing the relative durations of the several winds during the hours in any part of which rain fell, from observations in the years 1857 to 1859—the falls under half an inch, those of half an inch and upwards, and rain in general, without reference to its amount, being considered separately.

Direction of the wind.	Rain under half an inch.	Rain half an inch and upwards.	Rain generally.
N.	0·68	0·67	0·68
N.N.E.	1·49	2·18	1·68
N.E.	0·93	1·55	1·10
E.N.E.	1·65	4·37	2·41
E.	1·34	1·71	1·44
E.S.E.	1·68	0·83	1·45
S.E.	1·29	0·67	1·12
S.S.E.	1·17	0·75	1·05
S.	1·00	0·60	0·89
S.S.W.	1·20	0·67	1·05
S.W.	0·79	0·83	0·80
W.S.W.	0·64	0·43	0·58
W.	0·68	0·36	0·59
W.N.W.	0·58	0·28	0·49
N.W.	0·50	0·24	0·43
N.N.W.	0·64	0·39	0·57
Calms.	0·74	0·48	0·67

hours. From the temperature of the air and of evaporation, the pressure of vapour and the relative humidity were deduced by hygrometric tables.

The Monthly and Annual Means of the Relative Humidity furnished by six daily observations, from 1854 to 1859, are as follows:—

	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Year.
Means 1854–1859	82	80	77	72	70	74	73	73	77	76	78	81	76

The following is a Table showing the average state of the sky:—

	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Year.
Means 1854–1859	7·0	7·0	6·0	6·0	5·0	6·0	5·0	4·0	5·0	6·0	7·0	8·0	6·0

The meteorological day having been regarded since the establishment of the Observatory as beginning at 6 A.M., local civil time of the day of date, the custom was introduced, in January 1856, of reading and setting both the maximum and minimum self-registering thermometers at 6 A.M., terminating the day of date, with the view of ascertaining the highest and lowest temperatures that occurred within each successive space of twenty-four hours.

As the reading the minimum thermometer at 6 A.M., from the proximity of that hour to the time of minimum temperature, necessarily led to the loss of many of the true minima, and to the record as such of other lower temperatures which were in fact not true minima, and since the aggregate of the temperatures recorded as minima was consequently lower than the aggregate of the true minima, the hour of reading the minimum thermometer was changed, January 1, 1858, from 6 A.M. to 2 P.M., the temperature being recorded as the minimum of the day that included the hour of reading. By thus reading the minimum thermometer at an hour near to the ordinary time of maximum, no minimum could be lost, excepting when the temperature at 2 P.M. was lower than any that had occurred during the previous twenty-four hours. The maximum thermometer continued to be read as before, at 6 A.M., the temperature that it indicated being recorded as the maximum of the twenty-four hours just terminated.

The self-registering thermometers, for recording the extremes of temperature in the shade, are attached to the same horizontal strip of wood with the standard and wet-bulb thermometers. The

following are the average maxima and minima temperatures for the respective months:—

MAXIMA.

	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1854–1859	42·9°	43·4°	52·2°	64·7°	75·9°	87·6°	91·2°	86·6°	82·2°	70·8°	57·5°	46·7°

MINIMA.

1854–1859	−10·5	−11·0	− 1·8	15·9	31·0	37·2	47·5	43·8	34·9	25·4	13·6	−3·1

The anemometer (Robinson's), prior to June 1854, was mounted over a temporary shed attached to the N.W. corner of the old Observatory. The floor of this shed, its roof, and the horizontal plane in which the cups revolved were respectively 6 feet, 12 feet, and 20 feet above the floor of the Observatory.

On June 26th, 1854, the anemometer was moved to the top of a conical wooden tower standing at a distance of about 20 feet N.W. from the N.W. corner of the main building. This tower, originally built for Osler's anemometer, was about 30 feet in height. The anemometer continued in operation in this latter position from June 28th, 1854, till June 11th, 1855, when it was mounted on the tower of the new Observatory. The centres of the cups in the present position of the anemometer revolve in a horizontal plane 4¼ feet above the balustrade. The clockwork and papers for recording the direction and velocity of the wind are supported by a platform immediately under the deck-roof of the tower.

SUNDRY NOTES.

30. *Meteor of November* 11, 1864.—Last night I caught sight of a very beautiful meteor, of which I sent a short description to 'The Times.' It was too low down in the south to belong to English observers for its height and distance, &c. Time $5^h\ 35^m$ P.M. The sky looks threatening to our meteor-observations on Monday morning. An observer in London, Mr. T. Crumplen, has promised to look out from midnight until daybreak on Monday morning, in concert with our simultaneous observations here.—A. S. HERSCHEL.

31. *On the November Meteors.*—The 14th November was *no event* at all this year. For an hour the sky was here cloudless, or

nearly so, between 12½ and 1½ A.M. On Monday morning, the 14th inst., but one meteor only was coming from Leo. It was a fine one certainly, in brightness and length of path and in leaving a streak; but its solitariness proves sufficiently that nothing was to be expected before daybreak on that morning, even if the sky had not become completely overcast, with thick rain, as observed at intervals, for the remainder of the night. I doubt if any observers, either at home or abroad, will signalize anything remarkable as having taken place this year at the November epoch. This is, however, quite contrary to my expectations, as at the end of September and beginning of October meteors coming from the east were unusually abundant, particularly on the 18th October, P.M., when there was a shower of them from that quarter—*very fine ones*, 15 per hour.—A. S. HERSCHEL.

I have just read your note in 'The Times,' describing a meteor seen by you on Friday evening last. I saw the same. I noted the time, as nearly as I could, to be 5^{h} 35^{m} P.M. by railway time. It appeared to move deliberately in a nearly horizontal direction, and, as nearly as I could judge, about 10° or 15° above the horizon. I only saw it cross an opening in my shrubbery. It disappeared behind a cypress tree a few degrees eastward of the meridian. I judged it to be about as brilliant as a Roman candle-ball at half or three-quarters of a mile distant, with a tapering tail of a very few degrees. Indeed it might almost have been taken for a Roman candle discharged horizontally. I could not detect any colour, nor alteration in brilliancy, during the short time it was in view.—E. JONES.

Accept my thanks for your welcome letter regarding the meteor of Friday evening last. It is curious that it would appear to have been seen only in this part of Kent. From the low apparent altitude, it was doubtless very distant, and belongs to French rather than to English territory. My object in inserting the observation in 'The Times' was to recall to mind the meteoric epoch of November 14th, made famous by the display in America, A.D. 1833, which will (in all human probability) again astonish the astronomical world in 1865, '66, or '67. It put in no appearance on Monday morning last. In connexion with this phenomenon the meteor of Friday evening last is interesting, but not at all as connected with the late gale which unhappily crossed over England on the Sunday following. I enclose the printed form of registry of the British Association for luminous meteors (of which Committee I am at present the Hon. Secretary); and should observations of meteors or shooting-stars at any future time occur to you to forward to Mr. Glaisher, to myself, or to any of the Committee, the British Association will be greatly indebted to you for the trouble you take in communicating them.—A. S. HERSCHEL.

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

EDITED BY

JAMES GLAISHER, Esq., F.R.S., Secretary.

Vol. II. 1865, JANUARY 18. [No. 16.

S. C. WHITBREAD, Esq., F.R.S., President, in the Chair.

Charles William Stevens, Esq., Eldon House, Upper Tulse Hill, Surrey;
Captain Philip Howard, Colomb, R.N., 18 Edith Villas, Fulham;
were balloted for and duly elected Members of the Society.

The names of Six Candidates for admission into the Society were read.

LXXVIII. *On the Great Storm of July* 11, 1863, *in Russia.* By Bryan Donkin, Esq., Jun. In a Letter to his Uncle.

Moscow, $\left\{\begin{matrix}\text{May 22nd,}\\\text{June 3rd,}\end{matrix}\right\}$ 1864.

I have before me your letter to me, of November 1863, asking me to obtain, during my then proposed visit to Mr. Howard's, various information about the storm that destroyed Troitsky Mill on the 11th of July of that year. On the occasion of my late visit, I did my best to get information to comply with your request. I now subjoin the following details in answer to your

questions, with some additions, which you may find interesting, as you then spoke of presenting (following the suggestion of one of your friends) an account of this storm to the British Meteorological Society.

I would have sent these details before, but my time has been fully occupied since my return.

Effects of the Storm.

An enclosed tracing shows the exact course of the storm previous to its arrival at Troitsky Mill and through the large pine-forest to the west of the Mill. It also gives the exact dimensions of the gap made by the tornado in tearing up by the roots the greater number, and crushing some and laying down all those trees in the direction of the storm. The trees thus felled varied in diameter at the stem from 8 inches to 3 feet, and in height from 50 feet to 80 feet. The width of the space made by the storm is regular and definite (except at one point), and measured 700 feet!

At the part indicated by the letters *d d d* (Plate XXVI.), are now, and were at the time, a collection of some eighty small peasants' log huts, covered with straw, and about 15 feet high. The force of the storm has, as above stated, crushed down the *last* tree of the wood, situated within only 20 feet from the first of these houses, the remarkable fact being that none of these huts were injured; there has been only a little straw taken off one or two of the roofs; and having left these houses uninjured, it should have spent its fury, first, on the wooden bridge at *e* (Plate XXVI.), situated at a much *lower level*, tearing up and destroying all the planking and railing, &c., and then on the mill itself, at *f*, and on all the buildings adjoining, as described by Mr. Howard.

The (then) chimney at Troitsky, of brick, measured 105 feet high, with a base of 17 feet square, and measured at the top 7½ feet across outside. The upper portion of this chimney (90 feet long, and weighing 12,000 poods [say, 200 tons]), leaving only a piece 15 feet high, was lifted up in a vertical position in *one entire piece* a few feet into the air, and then fell to the ground at a distance of about 30 feet from its base, also in a vertical position, leaving a mass of bricks. It is to be noted that it fell in a *westerly* direction, in an exactly opposite direction to that of the storm, proving the presence of a whirlwind in this opposite direction.

Pieces of sheet roofing-iron, of a colour not to be mistaken, rags, and paper were found, after the storm, at a distance of 35 versts

(24 miles) from Troitsky, and also at all distances between this and the Mill.

A pond, situated in an exactly westerly direction to Troitsky, and at a distance of 4 versts from this latter place, was completely emptied by the tornado in its course, proving the *upward-drawing* tendency of the storm, so distinctly proved in the case of the chimney, as also by pieces of wood, timber, sheet iron, sand, straw, &c., that were carried up and were flying about in all directions at the time round Troitsky Mill.

In a main road, bounded by two rows of trees, situated at a distance of about two versts from Troitsky in an easterly direction, the trees were blown down in the same way as in the wood. This proved, also, that the storm passed off to the *east*.

In all, the number of persons killed by falling timber, &c., or débris, was five, as well as twenty-eight seriously injured.

Weather before and after, &c.

The weather in the neighbourhood of Troitsky a few days previous to that on which the storm occurred was generally cool for summer (say, about 16° R. in the shade), but changeable, with occasional light showers.

The morning of the 11th of July was fine and hot, with little or no wind. Towards midday, however, it turned excessively hot and sultry, with a temperature of (say) 20° Réau.; and this lasted until 5 P.M. For about an hour before the event, there was every indication of a *very severe* thunder-storm, and many very black clouds were visible.

The barometer was observed, Mr. Howard says, by a gentleman who lives near Troitsky (a former sailor), before, during, and after the storm; and I have requested Mr. Howard to ask if his observations were noted at the time. No one else observed the barometer.

The storm itself lasted at Troitsky not more than 2 *minutes*, the destruction of the wood and the mill occupying only this short space of time. The storm passed Troitsky about 6 P.M.

Hail-stones fell at Kondrona (one mile and a half from Troitsky to the north) of 4 inches across, as measured by Savage, the English mechanic, with his rule, of all sizes and shapes. The supposition of the people at the time was, as this hail-storm was very limited and did not occur at Troitsky even, that the water taken up from the pond, as before stated, fell in the form of these hailstones, or really in the form of ice of about these dimensions.

The air became cooler at Kondrona during this hail-storm, and much thunder was heard *there*; but in a quarter of an hour's time the weather was fine and very warm again.

Here end my details. I will now give you a few notes I have, relating to the direction this extraordinary storm took across Russia, and the damage experienced in other towns.

Direction across Russia, &c.

At Smolensk the same storm, on the same day, passed across the town and did much damage.

At Mr. Kozloff's Mill, near the town of Semnikoff (41° longitude), it did some damage. On reference to the map of Russia, you will perceive at once that Smolensk, Medin, and Semnikoff all follow latitude 55° and all a little to the south, proving clearly that the direction of this storm was somewhat south of this latitude, and direct *from* west and *to* the east.

Watt, the paper-maker, writing to *Savage*, in a letter dated 8th of August, 1863, says, "We were all sound asleep (at ½ past 11 to 12 at night). When I awoke first, I thought my house was *in* fire and the rain was pouring in at the windows, and hailstones—lightning without ceasing, wind roaring—all my windows broken. I never got such a fright in all my life; I am not the better *of* it yet. It did no damage to any other place here, only a tumbling down a tree here and there; but, with you, *you had it in style.* You will see by the map that our mill lies due east from your place."

At Moscow.

It next occurred to me that, as this storm must have passed within a degree of latitude from Moscow, it might have affected the barometer here. I therefore applied, a few days ago, to the Imperial Observatory here, requesting to look at their barometrical readings. To my astonishment, and to their shame, they make no observations, they informed me, on the barometer. However, they informed that at the Land-measuring Institution here (Messcebocur Insecnunur), they took hourly observations of the barometer night and day. On applying to this institution, I was politely received, and, with little delay, found the observations during the twenty-four hours, on the day in question (11 July, 1863). The facts of these readings coincide very curiously (as you will see by the following hourly observations, which I copied) with one's expectations. The barometer was falling from midday up to 10 at night, and remained from 10 to 12 (or midnight) *at a minimum* (29″·392).

July 11.	Barometer.	Temperature.	July 12.	Barometer.	Temperature.
	in.	°		in.	°
Mid-day..	29·498	60·4	Midnight	29·392	60·8
1 P.M....	29·492	61·7	1 A.M....	29·402	59·5
2	29·487	62·2	2	29·412	57·2
3	29·472	64·6	3	29·422	56·3
4	29·437	68·0	4	29·432	55·8
5	29·427	68·5	5	29·447	55·8
6	29·402	67·1	6	29·452	57·0
7	29·402	64·4	7	29·502	58·1
8	29·397	61·2	8	29·492	60·4
9	29·394	61·0	9	29·495	62·2
10	29·392	60·8	10	29·494	63·3
11	29·392	60·8	11	29·502	64·8

The 3rd column in this Table are the temperatures outside in the shade.

In their journal of this day, there is a note of which the following is a translation:—

7^h 10^m P.M., rained hard; large drops.

7^h 45^m P.M., stopped raining; from N.E. distant and loud thunder was heard (probably a local shower). No wind at all from 2 P.M. to 7 A.M. next morning; S. then direct to W. On previous day (10th) wind S.W.

This westerly direction of the wind agrees with the direction the storm took. At Moscow, on the day in question, the wind was too slight, and did not affect the instruments.

We thus have evidence of this storm between Smolensk and Temnikoff, distance about 11° longitude. It would be interesting to try and trace it further: possibly it originated in the Baltic. If so, and as it probably kept to the same latitude, it ought to have passed through Danzic, Königsberg and Wilna, to the W., and across Siberia to the E.

I enclose Mr. Howard's original letter; and he begs me to say that he has no objection to your publishing any part or the whole of this description.

LXXIX. *On the Great Storm of July* 11, 1863, *at Kondrona in Russia.* By W. Howard, Esq. Communicated by Bryan Donkin, Esq.

To describe the awful tornado, so as to give even a faint idea of it to those who did not see it, would require it to have been seen by a Russel, and sketched on paper by his pen. However, as you

kindly ask me to give you some information about it, I will endeavour to do so to the best of my ability. In fact, since I have somewhat recovered, I have written out some remembrances of that fearful day, and will now give you some extracts from that paper, viz.—

On the 11th of July, 1863 (O. S.), at about 12 o'clock A.M., I arrived at home after having made my journey to France, England, &c. Later in the day I went over to Kondrona Mills, dined &c., and meanwhile had my horses put to, to take me over to Troitsky, during which time I was detained at home by an accidental visitor, and it became so late that I had made up my mind *not* to go that evening; but, on considering that the horses were ready, I came to the conclusion that it would not take me a long time to run over and see at least some part of the factory, if not all, and started accordingly. I merely mention this to prove that it was, in my opinion ordained by Providence that I should be there to witness the mighty power of Him who created and can destroy all things.

From the time of my arrival at Kondrona, until about 5 o'clock P.M., it became very hot; and the sky was overspread with gloom, and there was every indication of a coming storm. Shortly after, the wind rose, and was accompanied by a shower of hail; the latter did not fall very thickly, but in extremely large pieces, some of the stones measuring 4 inches in *diameter* (*not* circumference), and others as large as hens' eggs. Then came the storm-cloud in all its resistless force, with incredible speed and great fury. The tornado was first seen at the back of my wood, in a field, going in a parallel line with the forest; it then made a sudden turn, taking its course through the wood, carrying boughs, earth, &c., high into the air, crushing down the large timber, and cutting a road, of about 200 yards wide, in a direct line with the Troitsky Mill. At this time I was at the factory, in company with Mr. Laudenbach, the steward, storekeeper, and others not far from us, when we observed a very peculiar appearance in the horizon, which led us to suppose there was a large fire at the back of the wood, throwing up, as it were, dense columns of black smoke in a conical form from the earth. However, after closer inspection we found it *not* a fire, but a terrific tornado, sucking up and drawing into its vortex objects both small and great, light and heavy, and whirling the same to an immense height, with a crackling, roaring, and most unnatural sound, similar in appearance, as I should suppose, to the eruption of a volcano. While watching it, I had

not the most distant idea of its fearful nature, and therefore took no precaution for my own safety or that of others about me. But my ignorance of its nature was soon dispelled by the manner in which the large pine-trees were torn up and laid level with the ground, in the same manner as long grass might be crushed beneath a heavy garden roller. After its having cleared the wood, it appeared to make a slight rise, as it only carried off the thatch from the huts which stood close to its edge; but in another second it swooped down with, if possible, renewed violence, tearing up large thick planks from the roadway of the bridge, which were fastened down with long, strong spikes, and then grasped the whole of the buildings belonging to the factory. This was to me the most awful moment of my life—expecting that everything would be levelled to the ground, and myself and others buried in the ruins. My first decision was to get as far as possible from the buildings, from which I therefore ran with all speed; but, seeing that the air was completely filled with planks, boards, roof-iron, &c., I considered an erect position the most dangerous; I therefore designedly threw myself upon the ground. This probably, by the mercy of God, saved my life (the idea of throwing myself on the ground suggested itself to me from having somewhere read of tornados, where the advice was given as the best means of safety to prostrate oneself on the ground). The next thing, I did after throwing myself down, was to protect my head with both hands, considering that the most vital part of my body. I had no sooner done so than I found boards, planks, timber, iron, sand, earth, &c. falling upon and around me. In a moment I perceived that my right arm and hand were injured, and the thought struck me that, if nothing worse than that happened to me, I should be fortunate; but this had no sooner passed from my mind than I was struck with a heavy blow between my shoulders, which for a moment seemed to deprive me of consciousness; but I immediately rallied, and, expecting every moment would be my last, I ejaculated a short but fervent prayer to Almighty God to spare my life, after which I still found things falling upon me; but was glad to find, after the lapse of a few minutes, that the chief of its force had passed. Assistance was immediately rendered to myself and others who had received damage from its effects. I was then carried into the office (which was the least injured building on the premises), where I remained confined to my bed for a week, at which time I was, by the blessing of God and surgical assistance, able to be removed to my home at Kondrona.

The effects of the hurricane on the factory were most devastating. For example, a *new* large chimney, of same size as that at Kondrona, was *not* blown down, but literally taken off its pedestal *en masse* and carried several yards, when it fell perpendicularly in a heap. Luckily it did so; for had it fallen in any other position, it must have crushed the machinery and destroyed many lives. All other chimneys about the factory shared the same fate. The roofs of all the buildings were almost entirely destroyed and cleared off. The *salle* was so much damaged, I have been obliged to take the whole of it down to rebuild it. The two large rag-houses were both in a few minutes levelled to the ground, the wind carrying away nearly the whole of the walls and roofs, with part of their contents. The storm was particularly violent on Laudenbach's house: it first levelled the fence, tearing up nearly every tree in the garden, carrying away the balcony, thrusting out all the windows, taking off the whole of the roof and a great part of the ceiling, beating the doors into fragments, and crushing the furniture to atoms, in fact leaving the house an entire wreck. The whole of Laudenbach's family were in the house at the time, and miraculously escaped with the most trifling injuries. In the factory about 300 windows were smashed, both glass and frames. To exemplify the immense power of the tornado, and its tendency to *suck* up or root out objects within its grasp, I may mention an instance of what took place with the *bell-post*; namely, this post was at its base 11 in. in diameter, narrowing gradually to about 5½ in. at the top, its *length buried in the ground 9 ft. 6 in.*, and its height *above* ground to the top 31 ft. (this post was put up by myself, and most securely rammed in with broken bricks, stones, earth, &c.). One would have supposed that the effects of the wind would have been to break off the post; but, most miraculous to say, it had not this effect, but literally *drew it up whole from the earth*, and threw it down *un*broken. The steward had, a few seconds before, clung to this post for security, but happily got away from it ere the mighty power of the wind had exerted its full force, and thereby probably saved his life.

The strength of the wind was proved in another instance, by some of the sheet-iron, with portions of window-frames, rags, and paper from Troitsky, being found in a field upwards of *thirty* versts distant. There were also collected in a field on the other side of Kalonga road, at least a verst from the Mill, several waggon-loads of the roof-iron, &c.

When it is remembered that of all the numerous buildings in

connexion with the Troitsky Mill, not one remains perfectly whole and entire, that sheet-iron, bricks, stones, boards, planks, timbers, and vitriol were falling and flying about in every direction, and that the whole wreck and destruction was the work of a few minutes, giving but little warning and no time for flight, it must be considered almost miraculous, and a most signal mercy, that so few human beings were killed and injured. There were two women killed on the spot, one of whom was close to my side; a third woman was so much hurt that she died the following day. There were six other persons seriously injured, besides eighteen others more or less wounded, making in all a total of only twenty-seven individuals personally sufferers by this dreadful calamity.

I consider that the pecuniary loss to the factory will be perhaps from 25,000 to 30,000 silver roubles. Fortunately the machinery is nearly all uninjured. Of course the mill has been still ever since the misfortune happened, and will be so for some time to come, although we have nearly 200 men repairing it.

After the tornado had left Troitsky, it fell upon one of the neighbouring villages, beating down the priest's house, killing his wife, and injuring others in the house. A boy, about eleven or twelve years of age, was sitting outside with an infant in his arms, when they were both taken up into the air and carried over a deep ravine, into which they both dropped: the boy fell on the hard ground and was found dead; but the child fell into some water, and escaped with only a slight injury on the arms. At the *bottom* of this ravine two large stones were lying of great weight, which were, by the force of the wind, carried *up* from the bottom of the ravine to the top of the level ground.

Thus (although very feebly described) ends, so far as I am aware, that most terrible phenomenon that passed over Troitsky on the 11th of July, 1863 (o. s.), which will never be forgotten by me to the latest moment of my life; and, I trust, gratitude to God for sparing me alive will be as lasting as the memory of its awful and destructive character.

My own injury consists of four rather heavy contusions, viz. one on the shoulders, a second on the wrist and hand, the third on my left knee, and the fourth on the lower part of my left rib-bone, besides some other slight bruises. The latter are all now well, and the former are progressing as well and as fast as one can expect. I have to be thankful that I have no bones broken.

LXXX. *General Radiant-points of Shooting Stars, derived from Catalogues of Shooting Stars in the Reports of the British Association.* By A. S. HERSCHEL, Esq., B.A., and R. P. GREG, Esq., F.G.S.

SHORTLY after the occurrence in America of the extraordinary meteoric shower of the 13th of November 1833, an account of this phenomenon, by the late Dr. Denison Olmsted, was published in the 'American Journal of Science,' from which it appeared that the meteoric tracks on this occasion took their directions from a point (termed by him the *radiant-point* of the shower) which retained its place unchanged among the stars during the whole continuance of the shower*. The same peculiarity has since been observed in the annual meteoric shower of August 10, discovered in 1836 at Brussels by M. Quetelet†, and in the following year (1837) by the late E. C. Herrick in America. In 1839 the radiant-point of this shower was placed by Sir J. Herschel "at the star β *Camelopardi*," and there appears no valid reason up to the present time for preferring any other position for this radiant-point. To cite our own observations only, the radiant-position of the shower in question was in 1863 at κ *Persei*, and in 1864 at δ *Camelopardi*, distant not more than 5° from one another and from the star β *Camelopardi*‡. A similar fixity of the radiant-point can be observed in the annual meteoric shower of December 12, which, in 1863, was near τ *Geminorum*, and in 1864 near θ *Geminorum*, two stars little more than 5° apart§. The meteoric shower of April 20 was observed in 1864 to have its radiant-position 3° or 4° from α *Lyræ*, between β and κ of that constellation‖. On the 19th of April, 1839, Herrick observed the same radiant-point "near α *Lyræ*"¶. The radiant-point of the 2nd of January meteoric shower was first determined accurately by the late Stillman Masters, in America, at Æ 238°·0, N. decl. 46°·4, in 1863**. The same shower was observed in England in 1864, and the radiant-point of more than 100 meteors was fixed

* Am. Journ. Sci., 1st ser., vol. xxv. pp. 366 (note at foot of the page), 394, 405, and 407, January 1834.

† Bul. Ac. Roy. Bruxelles, vol. vii. pt. 2. p. 136, 1840.

‡ B. A. Reports, Lum. Meteors, Append. 6, 1864.

§ Month. Not. R. A. S., vol. xxv., March 10, 1865.

‖ B. A. Reports, Lum. Meteors. Append. 6, 1864.

¶ Am. Journ. Sci., 1st ser., vol. xxxvi. p. 362, July 1839.

** Ibid., 2nd ser., vol. xxxv. p. 150, May 1863.

on that occasion at ε *Quadrantis Muralis*, in Æ 234°·0, N. decl. 51°·0, within 5° of the former position observed in 1863*. The radiant points at least of four meteoric showers have therefore been established, since the occurrence of that in 1833.

The stability of meteoric phenomena thus exhibited by periodical showers of meteors made it desirable to inquire if the radiant-points of "*sporadic*" *shooting stars* could be similarly determined from observations accumulated during a long series of years. The "Catalogue of Luminous Meteors" collected by the late Dr. Baden Powell, during the fifteen years following 1845, and continued in subsequent Reports of the British Association, the Catalogues of M. Coulvier, and other less extensive observations afforded more than sufficient materials for this, and to develope a number of remarkable and unexpected results, of which the principal features (so far as space will permit them to be noticed) are for the first time embodied in the present communication.

The only maps well adapted for determining the radiant-points of shooting stars are those projected upon the gnomonic or ordinary "plane perspective" scale. In these, arcs of great circles of the sky are represented by straight lines either limited in length or indefinitely prolonged across the map. The maps of Sir John Lubbock, published by the Useful Knowledge Society, are of this kind, the sphere being projected upon the circumscribing cube; but the whole visible hemisphere of the sky is at no time represented upon a single page of the maps in question, and the apparent path of a meteor cannot always be prolonged continuously upon the same sheet from one end to the other of its visible track. To remedy this inconvenience (without which the maps in question are the best existing for observing shooting stars), a plane perspective view of the hour-circles and circles of polar distance in the latitude of Greenwich was prepared and printed, having the zenith for this latitude in the centre of the map, and extending on all sides to within 25° of the horizon, below which altitude the smallest stars cannot always be seen for reference as sky-marks. The eye is 4 inches perpendicular from the centre of the map. Professor Heis, Director of the Royal Observatory at Münster, having prepared and printed, independently, a similar planisphere, upon the same scale and to the same latitude (which is only ½° less than the latitude of Münster), the two planispheres were superposed, and were found to differ in

* B. A. Reports, Lum. Meteors, Append. 6, 1864.

their indications *nowhere so much as* 1°*. The small existing differences appeared to arise from unavoidable contractions of the paper in receiving the lithographic impressions. Observations of shooting stars cannot, on the other hand, be carried to such a degree of accuracy, nor are their flights in general so conformable, that the error in the position of a radiant-point, determined by means of either of these two planispheres, should exceed the error of the planispheres themselves at the point in question. This error (it has been observed) does not anywhere exceed 1°. The elliptic planisphere, so prepared, is alone sufficient to determine the radiant-point of a meteoric shower, if observations drawn upon an ordinary star-map are transferred to it, by their coordinates in Æ and N.P.D. For greater convenience in entering the observations, the stars of Bode's constellations (corrected in their magnitudes by unpublished observations of Sir J. Herschel) were projected upon the elliptic planisphere in twelve different positions of the sky, representing, in twelve maps, the appearance on a plane surface of the visible hemisphere at Greenwich at successive intervals (of two hours each) throughout the day, or year. With these maps (now completed and in course of publication by the British Association) the whole series of shooting stars before enumerated, numbering nearly 2000 available observations, were projected by Mr. Greg in date and apparent position, without preference or selection, exclusive of those observations in the catalogues which had reference to the well-known radiant-point of the 10th of August. A series of radiant-points of sporadic meteors was thus immediately developed, with unexpected distinctness both as to the limits of their duration, and the positions of the radiant-points. The following list of the epochs and positions of fifty-six radiant-points of ordinary meteors is drawn up by Mr. Greg, in comparison with a similar list of radiant-points published independently by Dr. Heis in the Astr. Soc. 'Monthly Notices,' vol. xxiv. p. 213 *et seq.* The list is illustrated by four figures (Plate XXVII) upon the scale of the "Celestial Chart of the Northern Hemisphere," pl. i. vol. i. of Arago's 'Popular Astronomy' (published by Messrs. Longman & Co., London, 1849), to which reference can be made for the Constellations in which the radiant points occur. The first two figures of the plate represent the radiant-points of Mr. Greg from January to June and from July to December; the last two figures, those of Dr. Heis for the same seasons of the year.

* Examples in the use of these planispheres will be found at the end of this paper, and in the Month. Not. R. A. S. vol. xxv. No. for 1865, March 10.

Centres of Meteoric Excursions or General Radiant-points of Shooting Stars.

Comparison of the Epochs and Positions of Radiant-points of Shooting Stars, concluded independently by R. P. Greg, Esq., and Dr. E. Heis.

Reference Number.	From observations contained in the Brit. Assoc. Catalogues, &c., 1845–63. (R. P. Greg.) Epochs in their order of commencement.	Number of Meteors Mapped.	Distinctive Numbers (Greg).	Position of Radiant. Right Ascension.	Position of Radiant. North Declination.	Observed at Münster, 1849–61. (E. Heis.) Distinctive Letters.	Right Ascension.	North Declination.	Epochs to the nearest half-month.
				°	°		°	°	
1	Dec. 20 to Jan. 30	20	ii	22	75	A_1	29	50	Jan. 1–15.
						A_2	15	63	Jan. 16–31.
2	Dec. 20 — Jan. 30	13	ii *a*	5	85	N_1	285	84	Jan. 1–15.
						N_2	0	90	Jan. 16–31.
3	Dec. 21 — Feb. 4	28	iii	68	17	AG_1			
4	Jan. 2 — Jan. 3	52	i	234	51	K_2	235	52	Dec. 16–31.
						K_1	242	51	Jan. 1–15.
5	Jan. 2 — Feb. 4	30	iv	133	40	? M_2	166	52	Jan. 16–31.
6	Jan. 5 — Jan. 25	15	iv *a*	173	32	MG_1			
7	Feb. 4 — Feb. 26	36	v	147	34	M_3	150	60	Feb. 1–14.
8	Feb. 7 — Feb. 26	20	vi	136	70	M_4	130	63	Feb. 15–28.
9	Feb. 9 — Feb. 17	13	vii	76	40	A_3	65	51	Feb. 1–14.
						A_4	91	37	Feb. 15–28.
10	Feb. 10 — Mar. 17	21	viii	168	9	S_1	170	11	Feb. 15–28.
						S_2	178	7	Mar. 1–15.
						S_3	173	23	Mar. 16–32.
11	Feb. 11 — Mar. 16	10	viii *a*	37	1	SG_1			
12	Feb. 19 — Feb. 26	10	vi *a*	220	84	N_3	0	90	Feb. 1–14.
						N_4	250	83	Feb. 15–28.
13	Mar. 3 — Mar. 27	11	xiii	44	72	N_5	340	80	Mar. 1–15.
14	Mar. 3 — Mar. 31	30	ix	145	67	M_5	125	52	Mar. 1–15.
						M_6	140	50	Mar. 16–31.
15	Mar. 3 — Mar. 31	18	x	186	58	? M_7	140	50	Mar. 16–31.
16	Mar. 12 — Mar. 20	20	xii	223	39	MG_2			
17	Apr. 1 — June 2	52	xi	194	52	M_7	160	53	Apr. 1–15.
						M_8	150	61	Apr. 16–30.
18	Apr. 2 — May 1	20	xiv	189	4	S_4	194	5	Apr. 16–30.
19	Apr. 8 — May 28	20	xix	227	−8	SG_2			
20	Apr. 12 — Apr. 13	17	xvi	276	26	QG			
21	Apr. 16 — May 3	30	xv	96	87	N_8	265	83	Apr. 16–30.
22	Apr. 19 — Apr. 20	25	xvii	282	33	DG_1			
23	Apr. 25 — June 4	28	xviii	255	48	DG_2			
24	Apr. 30 — June 4	15	xx	243	20	Q_1	218	20	May 1–31.
25	May 9 — June 3	16	xviii *a*	277	42	D			
26	May 9 — June 4	8	xxi	286	21	W	292	15	June 1–30.
27	May 29 — June 17	18	xxii	336	45	B_1	332	60	May 1–31.
						B_2	333	42	June 1–31.
28	June 1 — June 30	9	xx *a*	236	30	Q_2	242	12	June 1–31.
29	June 1 — June 30	12	xxiii	300	85	N_9	290	80	May 1–31.
						N_{10}	150	83	June 1–30.
30	July 2 — July 24	51	xxiv	291	53	B_3	315	54	July 1–15.
				to 313	43				
31	July 10 — Aug. 6	26	xxvii	257	13	Q_3	262	12	July 1–1
32	July 20 — Aug. 4	46	xxv	359	70	N_{11}	20	85	July 1–
						N_0	337	86	July 16
33	July 22 — Aug. 10	70	xxvi	344	12	T_1	314	15	Aug.
				to 327	10				

Centres of Meteoric Excursions or General Radiant-points of Shooting Stars (*continued*).

Comparison of the Epochs and Positions of Radiant-points of Shooting Stars, concluded independently by R. P. Greg, Esq., and Dr. E. Heis.

Reference Number.	From observations contained in the Brit. Assoc. Catalogues, &c., 1845–63. (R. P. Greg.)					Observed at Münster, 1849–61. (E. Heis.)			
	Epochs in their order of commencement.	Number of Meteors Mapped.	Distinctive Numbers (Greg).	Position of Radiant.		Distinctive Letters.	Right Ascension.	North Declination.	Epochs to the nearest half-month.
				Right Ascension.	North Declination.				
				°	°		°	°	
34	July 29 — Aug. 22	123	xxiv *a*	302	44	B_4	306	59	Aug. 16–31.
				to 288	42	B_0	302	65	July 16 to Aug. 15*.
				and 298	58				
35	Aug. 6 — Sept. 10	80	xxix	0	90	N_{12}	295	79	Aug. 16–31.
						N_{13}	130	84	Sept. 1–15.
36	Aug. 7 — Aug. 16	...	xxviii	45	55	A_0	50	51	July 16 to Aug. 15*.
				to 20	62				
37	Aug. 17 — Sept. 12	9	xxvii *a*	245	5	Q_8	262	12	July 1–15.
				to 262	12				
38	Aug. 17 — Sept. 30	18	xxiv *b*	282	42	B_5	293	57	Sept. 1–15.
			or						
			xxx *a*						
39	Aug. 17 — Sept. 30	150	xxx	333	50	EG			
				i. e. 314	52	E	330	50	Oct. 16–30.
				to 347	47	A_{11}	35	63	Sept. 1–15.
				and 333	41	A_{12}	44	63	Sept. 16–30.
				to 333	62	A_{13}	51	61	Oct. 1–15.
40	Aug. 18 — Sept. 29	27	xxxi	13	34	R_1	53	35	Sept. 1–15.
			or			R_2	46	37	Sept. 16–30.
			xxx *b*						
41	Aug. 22 — Nov. 5	27	xxxii	1	15	T_2	343	10	Sept. 1–15.
						T_3	1	11	Sept. 16–30.
						T_4	3	11	Oct. 1–15.
42	Sept. 6 — Nov. 23	18	xxxiv	22	−9	TG			
						U	10	−11	Oct. 16–31.
43	Sept. 20 — Oct. 11	35	xxxv	83	48	AG_2			
44	Sept. 25 — Oct. 10	16	xxxvi	51	84	N_{14}	65	84	Sept. 16–30.
45	Sept. 27 — Nov. 2	67	xxxiii	14	58	A_{14}	20	42	Oct. 16–31*.
						A_{15}	25	40	Dec. 1–15*.
46	Oct. 3 — Oct. 20	11	xxxvii	140	45	LG			
						?L_1	115	55	Dec. 1–15*.
47	Oct. 4 — Nov. 10	35	xxxviii	45	33	R_3	45	32	Oct. 1–15.
48	Oct. 18 — Nov. 3	30	xxxix	83	12	O	75	40	Oct. 16 31*.
49	Oct. 20 — Nov. 21	33	xl	91	56	F			
50	Oct. 31 — Dec. 9	14	xliii	139	7	LH			
51	Nov. 1 — Nov. 23	75	xli	16	49	AG_3			
52	Nov. 7 — Nov. 15	...	xlii	153	22	L_0	150	28	Nov. 1 30*.
53	Nov. 23 — Dec. 9	9	xlv	279	56	DG_3			
54	Nov. 24 — Dec. 10	37	xliv	59	58	A_{16}	37	59	Dec. 16 31.
55	Nov. 26 — Dec. 30	84	xlvii	96	36	G			
						?L_1	115	55	Dec. 1 15*.
56	Nov. 27 — Dec. 19	10	xlvi	157	71	KG			

Total meteors............ 1746
Days 1655
Meteor-showers 56

(*) Radiants marked thus are extracted from the work by Dr. Heis, entitled 'Die Periodische Sternschnuppen.' (4to. Cöln, 1849.)

Each of the foregoing fifty-six radiant-points depends upon an average of one meteor *per diem* recorded for 30 successive days, which is the average duration of a meteoric shower. Even cursory observations are calculated to add to the precision with which it will in future be desirable to fix the epochs and positions of these radiant-points. Now that the epochs and positions of the principal radiant-points of ordinary shooting stars are for the first time accurately circumscribed, it may be expected that fireballs and meteorites will also be found to derive their directions from the same or at least from similar centres of excursion. The verification of this conjecture will be an interesting application of these results to future observations*.

* The following instructions for using the planispheres have lately been circulated:—

"When the track of a shooting star has been referred to the sky by means of any known stars, as, for example, those in the charts of the Useful Knowledge Society, &c., the polar distance and right ascension of the beginning and end of the meteor's path can be ascertained from the meridians and other lines of the charts, with at least the same amount of accuracy as that with which the meteor is observed. The meteor can then be transferred to the elliptic planisphere by choosing a convenient hour-circle (straight line from the North Pole) in the planisphere as first meridian (or equinoxial colure) for the zero of right ascensions. The right ascensions are reckoned from the first meridian towards the left, in the direction of the hands of a watch; and the south meridian mark of the planisphere should be made to point to

0° of right ascension	for 10 o'clock P.M.,	in the middle	of	October,
30°	,,	,,	,,	November,
60°	,,	,,	,,	December,

and so on, for evening observations, in the remaining months of the year. The elliptic curves representing the circles of polar distance remain the same for every position of the first meridian. The beginning and end of a meteor (or of any number of meteors) can be represented on the elliptic planisphere by points, by means of their coordinates in north polar distance and right ascension reckoned from any such first meridian. The north polar distance is reckoned in degrees outwards from the North Pole of the planisphere. The straight line which connects the two points of beginning and end of a meteor represents the track of the meteor correctly, and passes through every degree of right ascension and north polar distance actually traversed by the meteor in the sky (rare cases only excepted, where meteors follow *crooked* paths).

"It is the property of the elliptic planisphere that the straight line representing the track of a meteor, prolonged backwards across the whole width of the planisphere, contains every radiant-point from which it is possible the meteor could have been directed. This arises from the plane-perspective projection adopted in the planisphere, by virtue of which great circles in the sky are represented by straight lines upon the paper. If two meteors have been observed, and their tracks, prolonged backwards upon the planisphere, intersect one another in a point, this point, supposing the meteors to have appeared from the same radiant-point, is the common radiant-point of the two meteors. If more

LXXXI. *Observations on Meteor-showers and their Radiants.* By R. P. Greg, Esq., F.G.S.

Meteor-showers are without doubt more numerous and definite in their characteristics than could, a few years since, have been demonstrable. An examination of the foregoing list of radiants of meteor-showers, based upon results obtained by the analysis of an immense number of observations of shooting stars, made quite independently in this country and in Germany, will show that some real progress has recently been made in this branch of science. The results arrived at by Professor Heis, of Münster, are in general strongly corroborative of those obtained by Mr. Greg, of Manchester; though in certain cases the latter exhibits radiants not given by the former, and *vice versâ*. Professor Heis has, somewhat arbitrarily, divided his meteor-showers and radiants into bimonthly divisions, and has thus not unfrequently presented the same shower with a multiplicity of radiants more or less closely allied to each other. Mr. Greg has endeavoured to give as nearly as possible the precise duration and limit of each shower, as well as the average position of its connected radiant. The general results

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than two meteors have been observed, directed from the same radiant-point, the common intersection of their tracks prolonged backwards upon the planisphere is the common radiant-point of the whole. This is in general a contracted area, a few degrees in diameter, rather than a point. Centres of radiation also coexist, sometimes four or even five together in different parts of the sky, creating apparent confusion in the direction of the meteors; but this apparent confusion *always disappears* on applying the mode of projection of this planisphere to the observations. Star-charts are in process of publication by the British Association for the purpose of assisting observers in this mode of projecting their observations of luminous meteors.

"The second or circular planisphere is drawn to ascertain the altitude and azimuth of a heavenly body whose hour-angle and north polar distance have been correctly laid down upon the elliptic planisphere. The circular planisphere is drawn upon the same scale as the elliptic planisphere, and can be applied to it (by the centre and meridians) in the same manner as a transfer, upon which it is generally advisable to draw meteor-tracks, rather than upon the planispheres themselves. Transfers of meteor-tracks upon thin tracing-paper may be applied alternately to one or the other of the two planispheres. They form the best records which can be kept of meteor-observations, for which purpose the position of the centre of the planisphere, and of the north and south meridian line, should be drawn upon the transfer, and also the degree of right ascension (before described) which corresponds to the south meridian mark of the planisphere at the time of the observation. The circular planisphere is chiefly used to determine the height of a meteor which has been accurately observed at two or more distant places of observation."—Editor.

may then be summed up with a tolerable degree of certainty as follows:—

1st. *As regards the Meteor-showers.*—They appear to *endure* for almost any period from twenty-four hours to eight or possibly ten weeks, differing greatly from one another in their richness or intensity of display. In some there appears to be a tendency to maximum display on particular dates—as, for example, xlvii (No. 55), lasting from November 26 to December 30; but the most abundant display occurs from December 9–13. This shower is one of the few yet shown to be actually connected with large bolides and an aërolitic epoch (*vide* Astr. Soc. 'Monthly Notices,' vol. xxv.). In others no such tendency to a maximum can be perceived. The *average duration* of meteor-showers may be taken as lasting from three to four weeks, and the number as yet ascertained fully fifty. This number will probably not be much increased, at least for those seen in northern latitudes, unless in the case of special very short-lived showers, such as xvi, xvii (Nos. 20, 22), and others whose radiants culminate just before dawn. There may clearly be as many as four or five meteor-showers, each with its belonging radiant, proceeding at the same time, as from the 10th to 19th of February, 10th of August, and 30th of November. There is no confusion or chance, but the showers are very regularly recurrent every year. Allowing a radiant-region of some 5° to 15° in diameter for every shower, what formerly were called sporadic shooting stars will become extremely scarce now that the principal showers and their radiants have been pointed out. The meteors of particular showers vary considerably in their distinctive characters, some being larger and brighter than others, some whiter, some more ruddy than others, some swifter and drawing after them more persistent trains than those of other showers. Much, however, remains to be accomplished in this department, as well as towards establishing the connexion between the epochs and directions of large bolides and meteorites and those of ordinary shooting stars.

Although, as a rule, the showers are very regularly recurrent every year, the well-known and great shower of Nov. 9–14, xlii (No. 52), is now supposed to reach its maximum every thirty-three years, and has until the last few years been for a length of time almost extinct. There are similar indications of an eleven- or twelve-year period of maximum in the showers ii, xx, xxxv, and xl (Nos. 1, 24, 43, 49); and the years 1848–52 appear to have witnessed maximum recurrences of the showers marked ii, viii,

xii, xviii *a*, xix, xx, xxii, xxiii, and xliv (Nos. 1, 10, 16, 25, 19, 24, 27, 29, 54).

The shower most regular in recurrence, and abundant in individual meteors, is the well-known shower of the 9th to 13th of August. But it lasts a few days only; and this shower appears also to have an eight-year period, diminishing in the years 1846, 1854, and 1862*. On the other hand, the long-enduring shower xxix (No. 35), August 6 to September 10, although not a rich one, is of very regular annual occurrence, and is remarkable for having its radiant-region very small and fixed. Other showers, as those marked xviii *a*, xxi, xxii, xxiii, xxvii *a*, xxxiv, xxxvii, xxxix, xlv, and xlvi (Nos. 25, 26, 27, 29, 37, 42, 46, 48, 53, 56), are comparatively sparse or of more rare occurrence. In these cases further observations are desirable, although their radiants are mostly well marked. The maximum display of iv *a* (No. 6) is from the 23rd to 26th, and of iv (No. 5) from the 25th to 31st January, of xxiii (No. 29) from the 13th to 17th, and of xx *a* (No. 28) from the 16th to 26th of June. The maximum of xxxviii, xxxix (Nos. 47, 48), is on and after the 18th of October.

2nd. *As regards the Radiants*.—The vanishing-point of the tracks, or the apparent centre of excursion, belonging to a particular shower, ring, or zone of meteors is perhaps better designated radiant *region* than radiant point. Practically the radiant or centre of radiation in many meteor-showers extends over an area of 5° or 15° in diameter, or even more. There are probably considerable oscillations of position included in the average of observations extending over more than fifteen years, in certain meteor-showers, but by no means in all. The configuration of the radiant-region appears in many such cases to be best represented by an ellipse, rather than by a circular figure or a point. It is noticeable that this elongation takes place generally in a direction perpendicular to the ecliptic or (in the case of radiants lying near the *Via Lactea*) in a direction parallel to the Milky Way. It has not been possible to decide in every instance the precise position of the radiant-region of each meteoric shower, nor on the other hand to decide always to which radiant every observed or described meteor undoubtedly belongs; but the sparser showers, or radiants of more rare occurrence, require confirmation from additional observations, and a few meteors were obliged

* The average of fourteen occurrences observed at Brussels between 1838 and 1861 is sixty-five meteors per hour in all the sky. The smallest number (thirty-three per hour) occurred in 1838.

to be rejected from the charts as entirely sporadic or as radiating from regions which it was no longer possible to define. In the majority of cases enumerated in the foregoing list, the meteor-showers are as clearly defined, as regards the time of their occurrence, duration, and position of the radiant-points, as in the case with the older and better-known showers of August and November.

The following peculiarities may be noticed as distinctive of the particular radiant-regions.

(*a.*) *Small and sharply defined. Showers* i, iii, vi *a*, xiv, xvi, xvii, xxix, xlvii (Nos. 4, 3, 12, 18, 20, 22, 35, 55).

(*b.*) *Extended.* Not sharply defined. *Showers* viii, xviii, xix, xxiv, xxiv *a*, xxvii, xxx, xxxvii (Nos. 10, 23, 19, 30, 34, 31, 39, 46).

(*c.*) *Elongated.* In a direction strongly inclined to the ecliptic, or nearly parallel to the *Via Lactea. Showers* ii, ii *a*, iv, iv *a*, v, vi, vi *a*, viii, viii *a*, ix, x, xi, xxiv *b* or xxx *a*, xxvi, xxvii, xxviii, xxx, xxxiii, xxxiv, xxxvii, xl, xxxi ? xviii ? (Nos. 1, 2, 5, 6, 7, 8, 12, 10, 11, 14, 15, 17, 38, 33, 31, 36, 39, 45, 42, 46, 49, 40 ? 23 ?).

(*d.*) *Twin or double. Showers* iv and iv *a* ; viii and viii *a* ; ix and x ; xx and xx *a* ; xxxv and xl ; xxiv and xxiv *a* ? (Nos. 5 and 6 ; 10 and 11 ; 14 and 15 ; 24 and 28 ; 43 and 49 ; 30 and 34 ?).

(*e.*) *Double.* Advancing with the time. *Showers* x–xi ; xx–xx *a* ; xxxv–xl ; xxiv–xxiv *a* ? (Nos. 15–17 ; 24–28 ; 43–49 ; 30–34 ?) ; vi and ix (Nos. 8 and 14), although coincident in place and consecutive in time, are connected respectively with vi *a* and x (Nos. 12 and 15) by intermediate meteors, and are distinct from one another. The last radiant advances with the time to xi (No. 17) ; ix, x, xi therefore present an interesting and well-established instance of the same shower enduring (from March 3 to June 2) a period of thirteen weeks, and having a radiant advancing throughout the interval in a right line. From xx to xx *a*, there is a distinct progress of the radiant-position with the time ; and a similar progress from A_1 to A_2 may be observed in shower ii (No. 1).

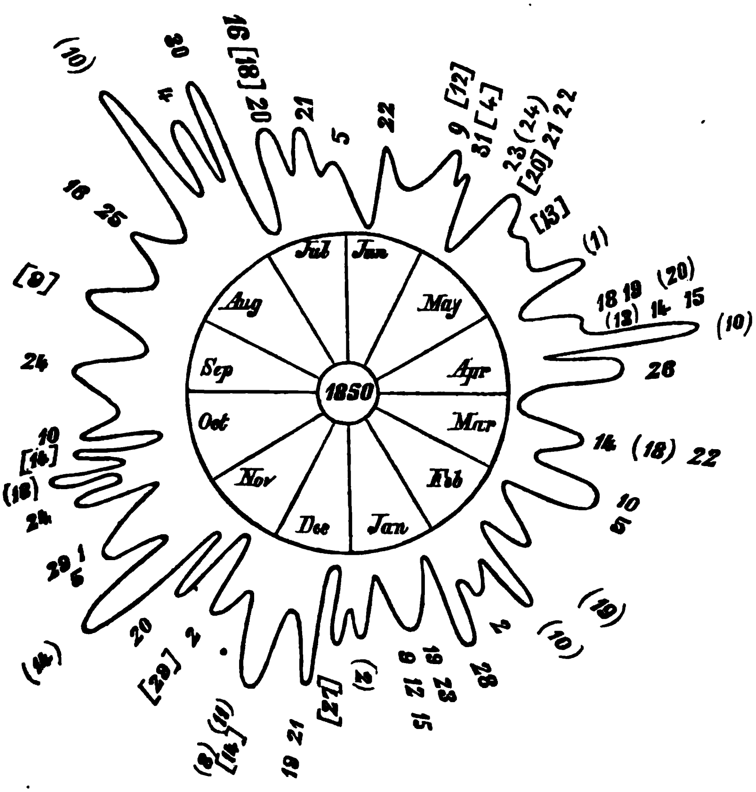
(*f.*) *Multiple.* Stationary, or advancing with the time. *Shower* xxx (No. 39, EG), represents a strongly marked and long-enduring meteor-shower, having a general centre of the radiants B 3, 4, 5, R 1, 2, A 11, 12, 13, and E, near ε *Lacertæ*, viz. EG. Intermediate meteor-tracks (which in this case are numerous) do not at present decide which of these radiants are separate or connected ; but a point near Æ 302°, N. decl. 50°, and another near Æ 333°, N. decl. 50°, represent two great centres of radiation for meteors

from July 2 till September 30 (Nos. 30, 34, 38, 39, 40). In the present condition of the observations it remains uncertain if xxx *a* (No. 38) (*vide* fig. 3) is a continuation of xxiv *a* (No. 34) or terminates, together with xxx *b* (No. 40), a general plane of radiation of extraordinary length, extending from *Lyra* to *Andromeda* across the *Via Lactea*, and having the general radiant xxx (No. 39) for its principal centre of excursions in *Lacerta*.

In collecting and entering the observations for these radiant points, the following list of recent star-shower dates was drawn up by Mr. Greg; and a diagram of dates preferred by fire-balls (fig. 16) was prepared by Mr. Herschel, from the Catalogue in the 'British Association Reports' for 1860. On two fire-ball dates, viz. the 10th of April and 18th of October 1864, star-showers were observed by Mr. Herschel (the last a remarkable shower*), with radiant-points at δ *Virginis* and ν *Orionis*; xiv and xxxix (Nos. 18 and 48) of the foregoing list. Large fire-balls also occurred, to verify the dates of the diagram, on the 29th of November and 27th of December, 1863; and on the 5th of July, 10th, 16th, and 26th of August, 24th of September, 19th of October, 29th of November, and 9th of December, 1864; as well as aërolites on the 7th of December, 1863, and 14th of May and 10th of August, 1864, of which accounts have been presented in the British Association Reports. The 27th to 30th of November is a date well defined for remarkable bolides and aërolitic falls; but to which (if any) of the contemporaneous star-showers (Nos. 53, 54, 55, 56, 1, 2, 3) these belong has not yet been ascertained. The radiant LH (No. 50) was noticed by Mr. A. S. Herschel for the first time in 1864.

* See 'Monthly Notice' R. Ast. Soc. for January 1865, and page 320 in this Number, for examples in the use of the plate.

Fig. 16. *Diagram of Dates preferred by Fire-balls, reduced to the Year* 1850.



Dates enclosed between parentheses are also star-shower dates; between brackets, dates of aërolites.

Catalogue of Recent Star-showers, by R. P. Greg.

Date of Observation.		Place of Observation.	Description and Reference, &c.
1803.	March 15	S. Pacific Ocean	Many meteors seen by A. von Humboldt.
	Apr. 20 (A.M.)...	Virginia, U. S. A.	Extraordinary shower of meteors.—E. C. Herrick
1832.	Nov. 18	India	Immense number of meteors seen.
1841.	Sept. 10	Ibid.	Vast numbers of meteors seen.
	Dec. 8	Hawkhurst (Kent)	Very unusual number of meteors, slow-moving, small (4–5 mag.); no trains. —Sir J. Herschel.
1842.	Aug. 7............	Ibid.	Many meteors; many with tails. Vanishing-point about *Perseus*.—Id.
	Aug. 12	Ibid.	Numerous meteors; many large, and mostly with trains.—Id.
1843.	Apr. 25	Ibid.	Several fine meteors observed to-night. —Id.
	Aug. 9............	Ibid.	Three meteors, two with trains from ϵ to θ *Pegasi*.—Id.
	Oct. 16	Nottingham	Many meteors seen by E. J. Lowe.
1845.	Oct. 18	Ibid.	Many meteors seen by E. J. Lowe.
	Oct. 31	Bombay	Many meteors seen by Dr. Buist.
1846.	July 25–30	Nottingham	Many meteors seen by E. J. Lowe.
1847.	June 17–22......	Parma	Many seen by Colla.
	July 7............	Ibid.	Many seen by Colla.
	Dec. 12	Nottingham	Many meteors seen in *Auriga*, *Gemini*, and *Taurus*, by E. J. Lowe.
	Oct. 10	Bruges & Parma	Many seen.
	Nov. 1	Nottingham	Many meteors seen by E. J. Lowe.
	Nov. 8............	Bombay............	Many meteors seen by Dr. Buist.
1848.	Jan. 2–3	Parma & Aix la Chapelle.	Many meteors seen by Heis and Colla.
	Mar. 27	Aix-la-Chapelle ..	Many meteors seen by Heis.
	May 2............	Ibid.	A number of fine shooting stars.—Heis.
	June 21	Ibid.	Many meteors seen.—Id.
	July 6, 22, 24, 28	Ibid. & Parma ...	Many meteors seen by Heis and Colla.
	July 29	Ibid.	Many meteors seen.—Heis.
	Aug. 23–29......	England............	Great numbers in *Ursa Major*, *Ursa Minor*, and *Draco* seen.
	Oct. 20–26	Aix-la-Chapelle & Bonn.	Radiants of meteors in *Auriga*, *Andromeda*, and *Lacerta*.—Heis and Schmidt.
	Oct. 22	England............	Many meteors about *Ursa Major* seen.
	Dec. 9–10	Parma	Many meteors seen by Colla.
1849.	July 23	Nottingham	Many meteors seen by E. J. Lowe.
	Aug. 12–14......	Sussex	Many meteors radiating from *Pegasus*.—Mr. Bulard.
	Oct. 22	Nottingham	Many meteors seen by E. J. Lowe.
1850.	Feb. 9	England............	Many meteors near *Ursa Major* seen.
	Apr. 20	Bombay, &c.	Extraordinary shower of meteors.—Dr. Buist.
	Sept. 2–4.........	Nottingham	Numbers of small meteors radiating from β *Pegasi*.—E. J. Lowe.
1852 & 1853	Sept. 6–20	Ibid.	Many meteors observed.—Id.
1854.	Sept. 17	Ibid.	Vast number of meteors.—Id.
1855.	Dec. 12	Ibid.	Many seen.—Id.
1856.	Jan. 27	Ibid.	Many small meteors.—Id.
	Oct. 21	Ibid.	Many meteors seen.—Id.

Catalogue of Recent Star-showers (continued).

Date of Observation.	Place of Observation.	Description and References, &c.
1856. Oct. 28–30	Bombay.....	Many meteors seen.—Dr. Buist.
1857. Jan. 7	Wrottesley........	Many meteors seen.
Dec. 7	Nottingham	Many meteors seen by E. J. Lowe.
1858. Sept. 22–24......	Aberdeen & Elgin	Many meteors seen by J. H. Gladstone.
Oct. 5	Wrottesley........	Very many meteors seen.
1859. Sept. 7, 12	Nottingham	Very many near *Via Lactea*. Radiant in *Cassiopeia*.—E. J. Lowe.
Oct. 9	Leeds	Very many small meteors seen.
1861. June 30	Nottingham	Many meteors seen by E. J. Lowe.
Dec. 24	Kent	Shower of fine meteors. Radiant-point in *Aldebaran*.—A. S. Herschel.
1862. Dec. 10–12	Manchester	Meteoric shower observed. Radiant between *Castor* and *Capella*.—R. P. Greg.
Dec. 10–12	Newhaven & Philadelphia, U.S.A.	Meteoric shower. Radiant between *Gemini* and *Auriga*. A. C. Twining and B. V. Marsh.
1863. Jan. 2 (A.M.) ...	Weld, U.S.A. ...	Eight bright meteors in ten minutes. Radiant-point R.A. 238°·0, N. decl. 46°·4 —S. Masters.
Feb. 14–15	Manchester	Numerous meteors radiating from *Leo Minor*.—R. P. Greg.
Apr. 20	England & Scotland.	Marked star-shower (Apr. 21 A.M.). A. S. Herschel and W. H. Wood.
Aug. 10	Hawkhurst, England, and on the Continent.	Extraordinary shower of meteors and bolides. Radiant *k Persei*.—A. S. Herschel.
Dec. 12	Hawkhurst and Manchester.	Star-shower. Radiant *τ Geminorum*. —Id.
1864. Jan. 2	Hawkhurst....	Marked star-shower. Radiant *ε Quadrantis Muralis*.—A. S. Herschel and R. P. Greg.
Apr. 10	Ibid.	8 to 10 bright meteors, radiating from *δ Virginis*.—A. S. Herschel.
Apr. 13 (A.M.)...	Ibid.	Shooting stars plentiful. Radiant region in *Cerberus*.—Id.
Apr. 20 (A.M.)...	Ibid.	Numerous bright shooting stars. Radiant in *Lyra*.—Id.
Sept. 20–24......	Ibid.	Numerous small shooting stars. Radiant in *Lacerta*.—Id.
Sept. 27	Ibid.	Many bright meteors. Radiants near *Capella* and *θ Ceti*.—Id.
Oct. 18	Ibid.	Shower of fine meteors. Radiant *ν Orionis*. —Id.
Oct. 31–Nov. 1	Ibid.	Numerous meteors. Radiant *ξ Persei*. —Id.
Nov. 13 (A.M.)...	Malta	Extraordinary shower of meteors.—Communicated by A. S. Herschel.
Nov. 28–Dec. 9	Hawkhurst.........	Numerous meteors. Radiant between *θ Aurigæ* and *θ Geminorum*.—A. S. Herschel.

BOOKS AND NOTICES.

XXIV. *Suggestions, Inferences, and Observations on the Tabular Results of the Barometrical and Thermometrical Record for the Thirty-seven Days from the* 1*st of October*, 1864, *to November* 6, 1864. By Lieut.-Col. AUSTEN.

THE author has laid the maxima and minima of each of those days, in both elements, on a diagram, with the direction of the wind, for those places of maximum barometer for each of the thirty-seven days. He says, if the within period may be deemed a fair criterion of the average barometric maximum ranges in Europe, he infers that the maximum balances itself periodically as a vibratory movement, oscillating like a magnet east and west of a meridian which is nearly midway between the two powerful icy poles of electricity, Iceland and Spitsbergen, and he considers that these oscillating movements extend over 1200 to 1400 English miles.

XXV. *On the Variations of the Reading of the Barometer and the Weather in the Months of October and November* 1864. By JAMES GLAISHER, Esq., F.R.S.

[From the 'Journal' of the Life-Boat Institution.]

THE variations in the readings of the barometer at the Royal Observatory, Greenwich, are shown in the annexed diagram, including forty-seven days, ending 30th of November, during which period there have been several severe gales of wind on our coasts, producing, as usual, distressing shipwrecks, attended with fearful loss of life.

The objects of the National Life-Boat Institution are so truly philanthropic, and co-extensive with the coasts of the British Isles, that I believe a few remarks in the 'Life-Boat Journal' on the readings of the barometer, during the period above named, cannot fail to be interesting to the gallant crews of its life-boats, and to our boatmen and fishermen generally.

The reading of the barometer from the 1st of October to the 15th day was always high, and every day above its average, frequently to the amount of 0·3 in. and 0·4 in., and on the 3rd day to 0·5 in. nearly. The direction of the wind, till the 8th day, was generally E. or E.N.E., and the greatest force of the wind during this interval was about 8 lbs. on the square foot; but usually the air was in gentle motion. From the 9th day the prevailing direction of the wind was N. and N.W., but at all times weak in strength. On the 16th day it changed to the S.W., and the barometer-reading descended below its average, and declined, as is

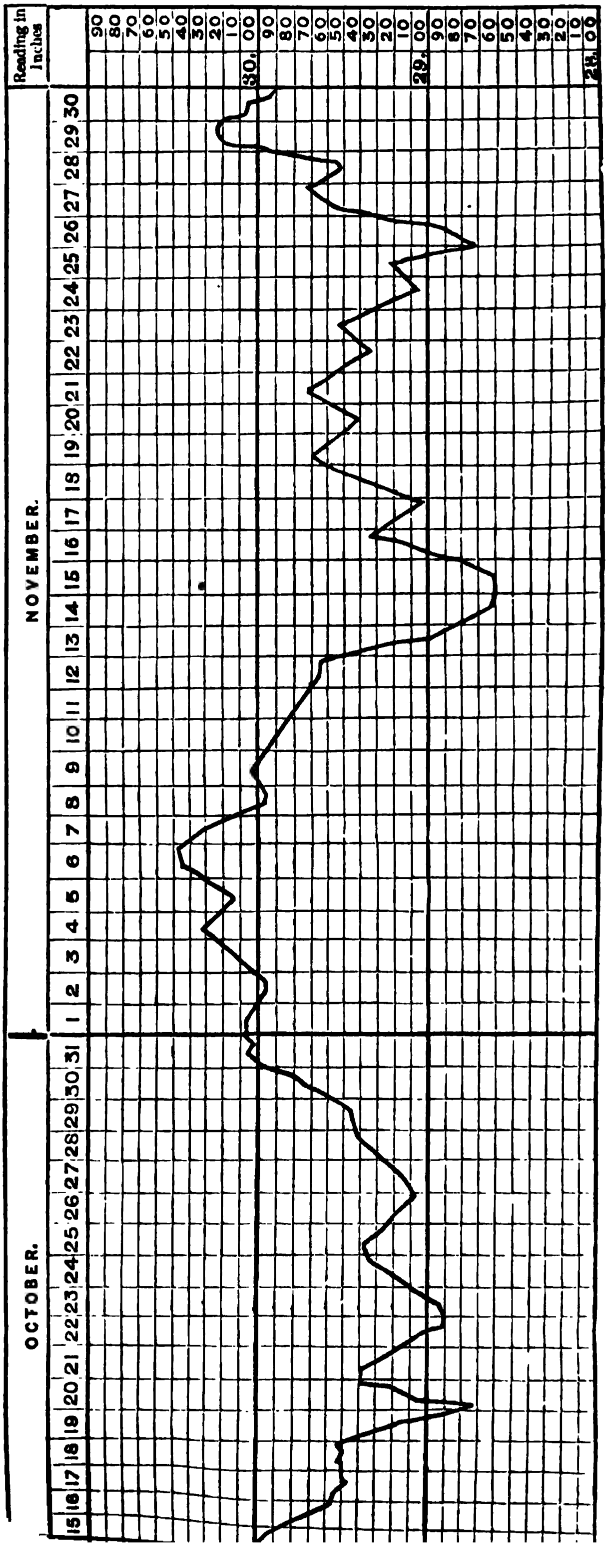
shown in the accompanying diagram, to 28·71 at 3 A.M. on the 20th, on which day pressures to 9 lbs. on the square foot took place. The reading of the barometer suddenly changed to an increase, and at midnight on the same day was 29·40 in., being no less than 0·69 in. increase in fifteen hours. It remained some little time at this point, and declined to 28·90 in. by 9 P.M. on the 22nd. From noon of the next day, the 23rd, its general tendency, as will be seen by the diagram, was increasing; it passed above its average on the 30th, having been fourteen days continuously below, and at times for twenty-four hours together as much as $\frac{3}{4}$ of an inch nearly. From the 23rd the course of the wind was mostly from opposite quarters, viz. S.W. and N.E., but at all times light, and sometimes the air was almost free from motion. The barometer-reading continued to increase, though with frequent slight falls, till November 6th, when the reading was as high as 30$\frac{1}{2}$ in., or 1$\frac{3}{4}$ in. higher than on 20th. On the 7th day the reading began to decrease, and passed below its average on the 10th, it having been above this point from October 30, or eleven days, a part of which time it was for twenty-four hours together more than $\frac{6}{10}$ths of an inch in excess. During the 13th and 14th days, the decrease was rapid, and the reading from noon on the 14th to nearly noon on the 15th varied only between 28·61 in. and 28·64 in.; thus the decrease amounted to 1·9 in. in eight days. At this time, at Greenwich, the greatest pressure we experienced was 3 lbs. only; and it is very remarkable that, with so low a reading of the barometer about London, there was scarcely any wind, whilst fearful storms were raging north of us. From the 15th, the barometer oscillated, but for the most part increased, and was 29·72 in. on the 19th, whilst the air was in gentle motion from the S.W. and S.S.E. Like changes followed, but decreasing readings were greater than increasing, till the reading of the barometer again was very low, viz. 28·72 at 1 A.M. on the 26th, accompanied with S.W. wind, blowing with a pressure of 5 lbs. on the square foot only. From this time the readings increased, and on the 30th passed above the average, having been below during eighteen days.

It cannot fail to be remarked that, at all times, when the reading of the barometer was above its average, the wind has everywhere been moderate in strength, but that the period of our recent heavy gales has begun shortly after the reading has descended below the average; these gales have also been the worst when the departures below have been the greatest, and the bad weather has ceased only on the average again being approached.

One fact may be learnt from these readings, and it is one I endeavoured forcibly to impress upon the fishermen of the Northumberland coast, when I first fixed the barometers there, *that at no time, and particularly during the winter months, should the warnings of the barometer pass unheeded*; for although the barometer-reading may be low (and, indeed, unusually low) in some localities, without the storm passing over these places, yet they may feel certain that bad weather or gales of wind are, at that very time, most likely raging not far from them, and which might

RAM EXHIBITING THE BAROMETRIC VARIATION FROM OCTOBER 15 TO NOVEMBER 30, 1864, AS REGISTERED AT THE ROYAL OBSERVATORY, GREENWICH.

BY JAMES GLAISHER, ESQ., F.R.S.



suddenly visit their localities without further warning. It is remarkable, indeed, that about London the barometer was (see the diagram) no less than three times a good deal below 29 inches, yet no storm of any moment visited us; but we have had sad evidence of the fearful storms then raging on our northern and eastern coasts; and one almost sees the agonies and hears the cries of the drowning men, women, and children at Tynemouth and Shields, imploring help from the plunging life-boat, two of whose noble crew perished in their humane efforts to succour their perishing fellow-creatures. All honour to these brave but nameless heroes, of whom England may well be proud; and well may we mourn over those who unhappily perish in their sacred work.

These sad wrecks were taking place all along our eastern and northern coasts, while we were in comparative calm.

I wish to impress upon all sailors and fishermen the necessity of care, when *continuous declining* readings of the barometer are proceeding, and of viewing such a state of things as plainly indicating approaching gales, which may not visit their own localities, but yet may do so; and if fortunately an indicated gale does not visit them on any special occasion, not to place less confidence in the barometer-warnings, but rather to be careful till that reading of the barometer be attained which is the average of the place.

It is an ascertained fact, that when great atmospheric disturbances take place, and great depressions of the barometer-readings occur, particularly when sudden, they are the certain and sure prognostications of the approach of storms: such signs no fisherman or seaman can, I think, now be so unwise as to neglect; for the caution thus given to him, conjoined with his own knowledge of the storms of the locality (with which he must be familar), will probably save him and others from loss of life and property. The Royal National Life-boat Institution, by placing reliable barometers (tested by me at the Royal Observatory, Greenwich) around the coast, and thus directly preventing loss of life, may not gain so much praise as when one of its life-boats saves a crew from the sinking ship, but I consider that it deserves equal credit for taking timely steps to warn our fishermen from going into that sea in times of danger. And surely the public will not fail to appreciate fully the feelings which prompt the Committee of the Institution to prevent, as far as possible, the necessity of having recourse to the life-boat, by timely warnings to those who otherwise might need its valuable and ever-ready services.

XXVI. *Radiant-points of Shooting-stars.* By A. S. Herschel, Esq.

[From the Royal Astronomical Society's 'Monthly Notice' for Dec. 9, 1864.]

On the 27th of September in the present year, wishing to trace to its source the prevalence of fire-balls in the fourth week of September, I watched carefully for radiant-points of periodical meteors. Two radiant-points of shooting stars, very distinct in their characters, presented themselves, in *Auriga* and in *Cetus*, viz.:—

Radiant A (fig. 1), R.A.=85°, N. Declination=50°;
Radiant T (fig. 2), R.A.=12°, S. Declination= 2°,—

the latter very nearly in the ecliptic, 85° from the apex of the earth's way, and the former 27° from the same apex, on a great circle nearly transverse to the ecliptic. The average duration of fourteen meteors from A was 0·71 second, and of eight meteors from T was 2·12 seconds. These numbers are to one another in the proportion of 1 : 3.

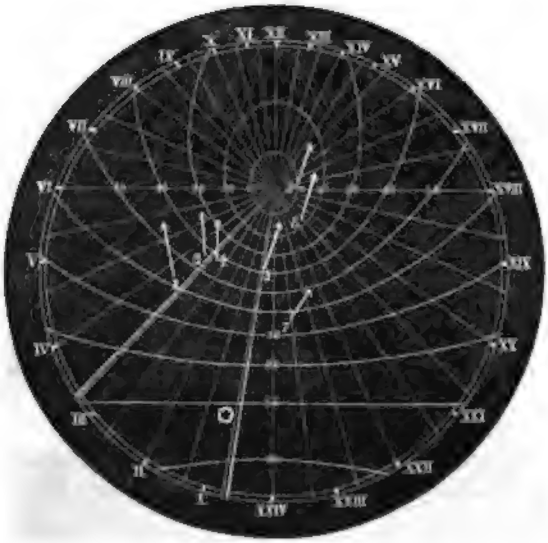
Fig. 1.—A, September 27th.

R.A. 85°; N. Decl. 50°.

As the altitudes of the radiant-points above the horizon differed very little from one another at the time of observation, the velocities of these meteors were presumably inversely proportional to their times of flight. The observations of the heights of shooting stars, in fact, lead to the conclusion that the length, in miles, of the luminous excursions of meteors depend not so much upon

the mass of a meteor as upon the depth of the inflaming atmospheric stratum through which it has to pass, and that this, in general, is the same for all meteors. In support of this general conclusion, it may be noticed that the average apparent lengths of the paths of the meteors in question were respectively 16° and 18°, although in all other respects the meteors were exceedingly

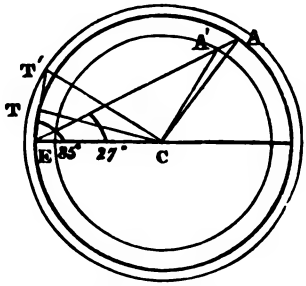
Fig. 2.—T, September 27th.



R.A. 12° ; S. Decl. 2°.

dissimilar. It is therefore warrantable to assume that the velocities of the meteors from A and T respectively were inversely proportional to their times of flight, or to one another in the proportion of 3 : 1.

Fig. 3.



If chords be drawn to a circle inclined respectively 85° and 27° to the diameter, as E T, E A (fig. 3), these are to one another in the proportion of 1 : 10, and represent the *geocentric* velocities of meteors when their *heliocentric* velocities are T C, A C, radii of the same circle A T E; and the heliocentric velocity of the earth itself (or velocity of the earth in its orbit round the sun) is represented by an equal quantity E C, another radius of the same circle A T E. If, however, the semi-major axes of meteoric orbits are one fourth

greater, or one fourth part less than the mean distance of the earth from the sun, it appears from the formula of Laplace,

$$v=\sqrt{2-\frac{1}{a}}$$

that the meteoric velocities, at the same distance, will be nearly one-tenth part greater, or one-fifth part less, than the velocity of the earth; as C T', C A'; and in this case the *geocentric* velocities will become

$$\text{E A}' : \text{E T}' :: 3 : 1,$$

and will be to one another in the proportion observed.

The above observations are therefore reconciled with one another by the supposition of two meteoric orbits; neither of whose semiaxes major differ more than a fourth part from the radii vectores of the earth. This supposition agrees with the evidence adduced elsewhere, by Professor Newton, Erman, and others, to show that the August and November rings of meteors very nearly coincide in their dimensions with the orbit of the earth. It adds fresh support to the conclusion that meteoric orbits approach in general very nearly to the circular form; but offers no explanation of their frequent *retrograde motions and large obliquities* to the ecliptic.

TABLE I. Shooting Stars observed at Hawkhurst, 1864, September 27 (together with a few preceding nights). Figs. 1, 2.

Meteors radiating from A (R.A. 85°; N. decl. 50°).

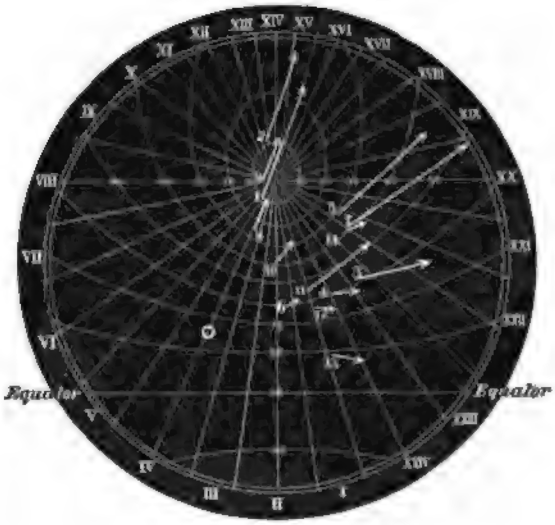
No.	G. M. T. 1864, Sept. 27.	Mag. comp. with stars.	Length of path.	Duration.	Streak.	Began.		Ended.	
						R.A.	N. decl.	R.A.	N. decl.
	h m		°	sec.		°	°	°	°
1	....	2½	20	0·8	....	19	26	0	19
2	....	3	15	0·5	....	0	28	354	14
3	....	3	6	0·5	....	252	10	252	4
4	....	2½	12	0·6	....	287	30	284	23
5	....	3½	15	0·3	....	192	84	230	72
6	....	2	10	1·0	with	82	51	68	56
7	....	3	15	1·2	....	302	46	298	35
8	....	2	15	0·7	with	29	2	19	−9
9	8 44	4	12	0·8	....	301	34	296	23
10	9 1	3	15	0·6	....	295	67	278	52
11	9 37	3	35	1·3	with	344	48	319	19
12	9 50	2½	10	0·5	....	321	28	314	22
13	10 27	4	15	0·6	....	85	73	110	88
14	11 14	3½	25	0·6	....	27	54	356	41
Average values			16	0·71					

TABLE I. (*continued*).

Meteors radiating from T (R.A. 12°; S. decl. 2°).

No.	G. M. T. 1864, Sept. 27.	Mag. comp. with stars.	Length of path.	Duration.	Streak.	Began.		Ended.	
						R.A.	N. decl.	R.A.	N. decl.
	h m		°	sec.		°	°	°	°
1	....	Capella	15	3·0	....	58	35	75	43
2	....	3	15	1·3	No streaks left.	320	81	230	72
3	8 7	α Lyræ	30	4·0		290	3	263	10
4	8 16	2½	15	1·6		45	49	60	60
5	8 52	α Lyræ	30	3·8		9	46	347	74
6	9 55	4	20	1·4		322	70	251	73
7	10 59	5	10	0·8		349	29	338	38
8	11 11	3½	15	1·1	....	92	38	105	39
Average values			18	2·13					

Fig. 4.—O, October 18th.



R.A. 90°; N. decl. 16°.

On comparing the observations of several bright shooting stars of the 18th of October inst. (Table II.) with those observed at Hawkhurst on the 27th of September ult. (Table I.), it appears that in this interval the radiant-point in *Cetus* has disappeared, while that near *Capella* has descended below the ecliptic to the neighbourhood of *ν Orionis*, preserving very nearly its former distance of 27° from the apex of the earth's way, and presenting

meteoric tracks nearly as swift as before. The remarkable brightness of the meteors of the 18th of October, from near the apex of the earth's way, and the permanency of their luminous streaks, afford a presumption that an unusual exhibition of the November meteoric phenomenon is not unlikely to take place on the mornings of the 13th or 14th prox. Nevertheless, from the coincidence of the full moon with the date in question, the circumstances in the present year are not favourable for observers of this phenomenon *.

TABLE II. Shooting Stars observed at Hawkhurst, 1864, October 18. Fig. 4.

Meteors radiating from O (R.A. 90°; N. decl. 16°).

No.	G. M. T. 1864, Oct. 18.	Mag. comp. with stars.	Length of path.	Duration.	Streak.	Began.		Ended.	
						R.A.	N. decl.	R.A.	N. decl.
	h m		°	sec.	sec.	°	°	°	°
1	10 20	α Lyræ	40	2·7	2·5	95	73	260	67
2	10 22	α Lyræ	30	2·5	2·5	164	81	254	61
3	10 26	1	25	1·3	1·5	18	32	352	27
4	10 43	4	10	0·6	....	29	29	16	28
5	11 1	2	25	1·0	....	12	59	315	47
6	11 12	3	6	0·5	....	55	29	47	31
7	11 14	α Lyræ	38	1·6	3·	7	53	317	37
8	11 27	2	12	1·2	1·0	89	63	92	76
9	11 50	2	14	0·8	2·0	135	84	240	80
10	11 55	2	13	0·8	2·0	61	51	45	61
11	11 58	Mars	32	1·5	4·0	42	34	1	41
12	12 2	2	8	0·6	....	39	25	30	23
13	12 7	3	12	0·6	....	39	9	28	7
14	12 14	2	8	0·4	2·0	7	51	356	50
Average values			20	1·15	1·5				

SUNDRY NOTES.

32. *Meteor of November* 20.—I was walking, with a friend from a little village in North Cheshire, called Mobberly, to Altrincham. The stars had been shining; but at $8^h\ 55^m$ P.M. they were completely hidden by the clouds. At that time the whole country seemed suddenly to be illuminated by a light more intense than that of sheet lightning. My friend noticed that at the first appearance of the meteor it had a reddish tint, which rapidly gave way to the dazzling bluish white which was so conspicuous.

* The phenomenon of November was observed at Malta on the morning of the 13th inst. *No trace of it* remained on the morning of the 14th inst.

Errata, &c. Figs. 1, 2, R.A. $0^h\ 40^m$, and R.A. $3^h\ 20^m$. Erase the fine lines and substitute fine lines in the places of the stronger lines. Fig. 2, No. 8, is an additional observation, the last meteor in Table I. being beyond the limits of the figure. Fig. 4, hours of R.A.:—To all the hours add 2.—A. S. H.

The meteor started almost from the zenith, falling in the N.E. direction through about 45°. After falling through about 20°, the brightness so far diminished as to give it the appearance of a large falling star; then it again strongly flashed forth light, and disappeared without any sound or any sparks. There was no wind. It certainly gave the impression of being below the clouds. —ELKANAH ARMITAGE.

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33. *Abstract of the Weather at Penzance and Neighbourhood for the Year* 1864.

Prevailing Winds at Penzance for the Year 1864.

	N.	S.	E.	W.	N.E.	S.E.	N.W.	S.W.
January	2	4	3	2	7	10	6	9
February	2	5	6	3	14	4	3	6
March	7	1	7	4	2	6	1	13
April	1	3	4	3	7	6	6	6
May	4	7	6	5	7	3	8	2
June	1	1	1	12	4	1	6	13
July	...	3	4	2	7	5	7	9
August	1	3	1	4	8	9	8	6
September	1	1	4	8	2	2	6	12
October	1	3	9	3	7	3	2	6
November	1	2	2	4	8	1	6	12
December	1	4	5	6	11	2	4	6
Total number of days ...	22	37	52	56	84	52	63	100
1863	21	25	5	56	53	48	85	141
1862	21	32	15	69	62	54	70	123
1861	18	25	11	54	71	59	68	138
1860	25	22	14	68	75	45	98	124

Mean Temperature at Penzance for the Years 1862, 1863, and 1864, kept at 12, Regent Square, 67 feet above low-water level.

	9 A.M.			Maximum.			Minimum.		
	1862.	1863.	1864.	1862.	1863.	1864.	1862.	1863.	1864.
	°	°	°	°	°	°	°	°	°
January	45·19	43·68	41·61	48·30	47·42	46·51	42·61	42·00	40·95
February	44·23	45·41	39·91	47·54	49·82	44·26	42·25	43·09	37·71
March	46·87	46·58	46·33	50·77	51·03	51·98	43·11	43·29	44·30
April	51·05	50·78	52·30	55·25	55·22	56·51	46·85	45·35	46·65
May	56·21	54·05	57·56	59·66	58·26	62·02	50·58	48·19	51·09
June	57·58	58·45	59·71	61·88	62·27	63·06	54·27	52·40	52·90
July	60·48	64·13	64·21	63·95	67·87	67·89	54·53	56·47	56·95
August	61·55	63·05	62·68	65·05	66·66	66·18	55·88	57·37	55·51
September	58·27	55·95	58·55	62·73	60·21	62·93	55·27	51·17	54·61
October	54·15	52·80	53·26	57·87	56·59	57·00	51·27	50·09	50·64
November	43·63	49·88	46·11	48·66	52·60	50·48	40·36	47·61	43·57
December	47·96	47·42	41·76	50·55	50·43	49·03	45·98	45·13	40·47

Rainfall at Penzance for 1859, 1860, 1861, 1862, 1863, and 1864.
Gauge kept at South Parade, 94 feet above low-water level.

	1859.	1860.	1861.	1862.	1863.	1864.
	in.	in.	in.	in.	in.	in.
January	3·18	7·83	1·51	4·99	4·43	3·36
February	2·30	1·89	6·62	2·13	1·48	1·66
March...............	2·74	3·02	2·93	5·06	3·29	2·63
April	3·10	1·14	1·39	2·91	1·60	1·28
May	1·04	3·63	1·29	1·99	2·16	1·33
June	0·59	5·00	2·17	3·26	4·29	1·76
July	1·00	1·68	6·81	3·59	1·44	0·77
August	3·40	5·29	2·02	1·81	3·91	1·25
September	4·42	3·52	3·51	3·47	4·09	4·03
October	5·34	3·86	1·92	6·83	3·36	2·67
November	3·62	3·99	7·23	4·05	3·75	5·15
December	8·28	8·40	3·58	4·55	4·20	3·94
Total............	39·01	49·25	40·98	44·64	38·00	29·83

General Notes.—There are many features in the weather of the year that has just closed which strike us as worthy of notice, compared with what we consider to be the general character of the neighbourhood. While we usually expect a considerable amount of rain, and otherwise a moist, damp, and mild atmosphere, we observe the contrary has been the case in the past year, inasmuch as the rainfall has not reached 30 inches, or nearly a fifth part less than last year, and the temperature has barely reached the average—the greatest amount of heat being on the 18th of May (74°), about which time there were three remarkably hot days; and easterly winds having prevailed during summer, the heat was less oppressive. The lowness of the temperature is also striking.—W. H. Richards, 12 *Regent Sq., Penzance.*

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34. ***Mean Monthly Values deduced from Meteorological Observations taken at Salisbury in the Year 1864.***

1864. Months.	Mean Reading of Barom.	Mean Temp. of the Air.	Mean Temp of the Dew-point.	Mean Maxim. Reading of Therm.	Mean Minim. Reading of Therm.	Wind. Relative Proportion of N.	E.	S.	W.	Mean Amount of Cloud.	Rain. Number of Days it fell.	Amount collected.
	in.	°	°	°	°							in.
January	29·971	37·0	34·3	43·2	31·5	9	8	10	4	6·5	14	1·9
February ...	29·755	36·5	34·0	43·7	30·5	15	4	5	5	6·6	12	1·5
March	29·486	42·5	39·4	53·4	34·7	8	8	7	8	6·6	17	2·8
April	29·887	47·8	40·6	60·4	36·4	7	12	6	5	4·9	12	2·6
May	29·818	55·3	47·9	69·3	44·7	5	14	4	8	5·5	9	1·3
June	29·787	56·6	49·8	70·2	47·9	6	1	6	17	6·6	13	1·3
July	29·840	60·8	53·9	77·4	48·3	10	5	4	12	4·4	7	0·4
August	29·909	59·1	49·8	75·3	46·8	8	6	6	11	4·8	8	1·3
September ...	29·755	56·6	51·8	69·7	47·4	5	1	7	17	5·9	21	2·1
October	29·646	50·1	45·5	61·1	41·9	7	11	5	8	6·0	9	1·9
November ...	29·539	41·1	38·8	51·1	32·6	9	6	7	8	5·2	14	3·3
December ...	29·828	37·5	35·3	42·9	31·9	10	8	8	6	8·8	12	2·9
Means......	29·768	48·2	43·4	59·8	39·8	......	......	......	......	6·0	......	......
Sums	......	......	......	......	......	99	84	75	109	......	148	23·3

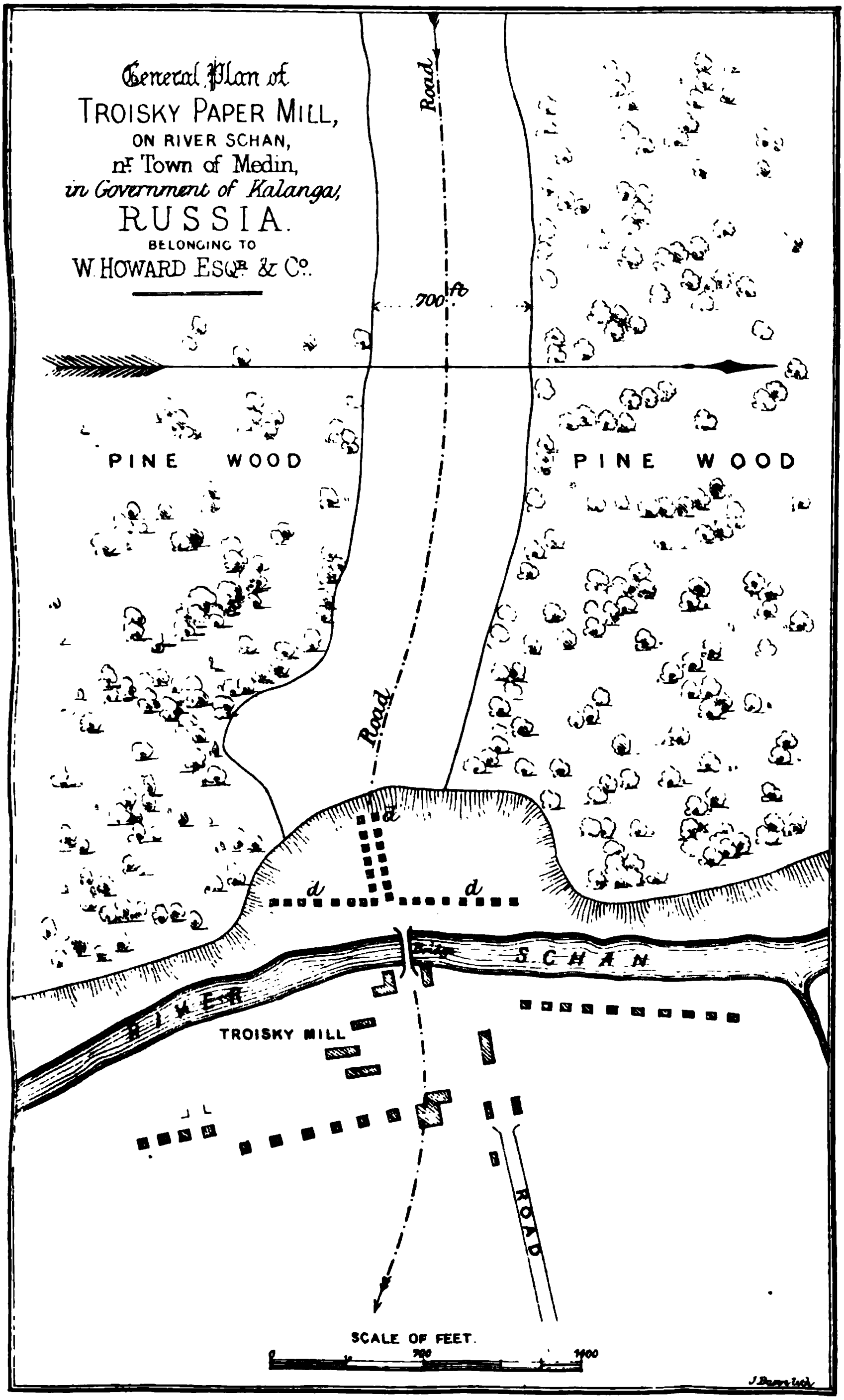
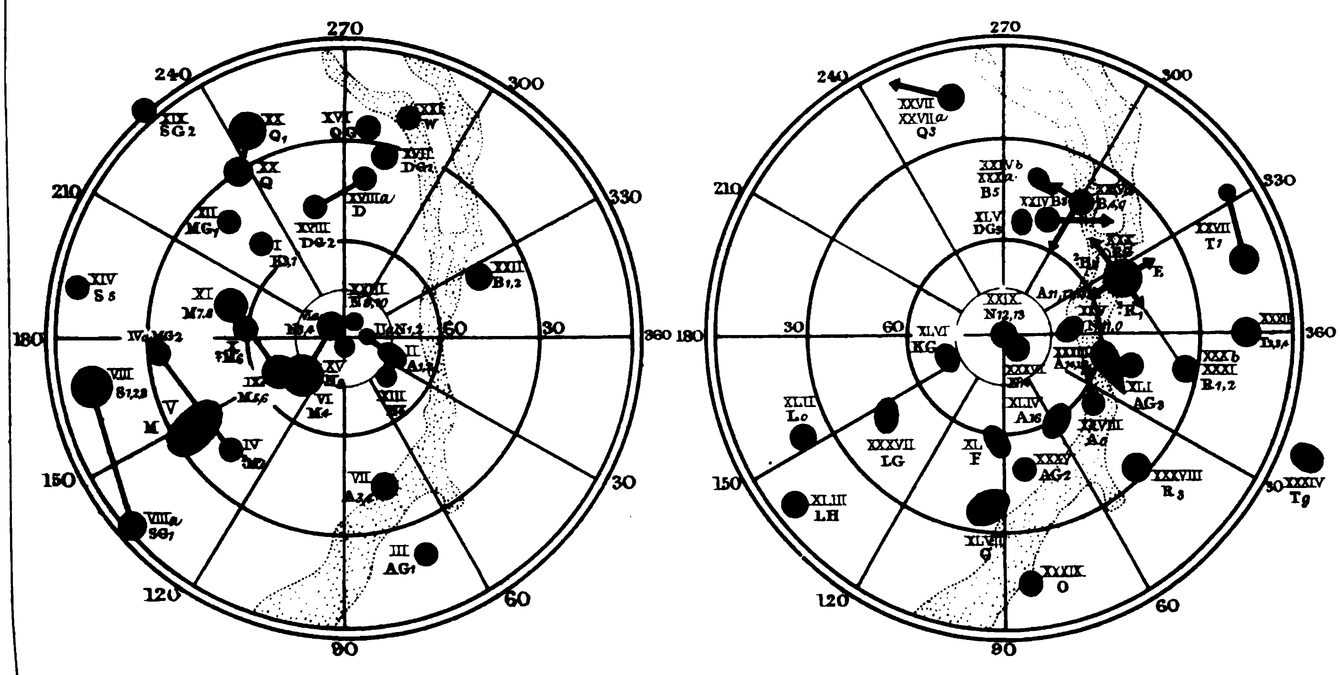
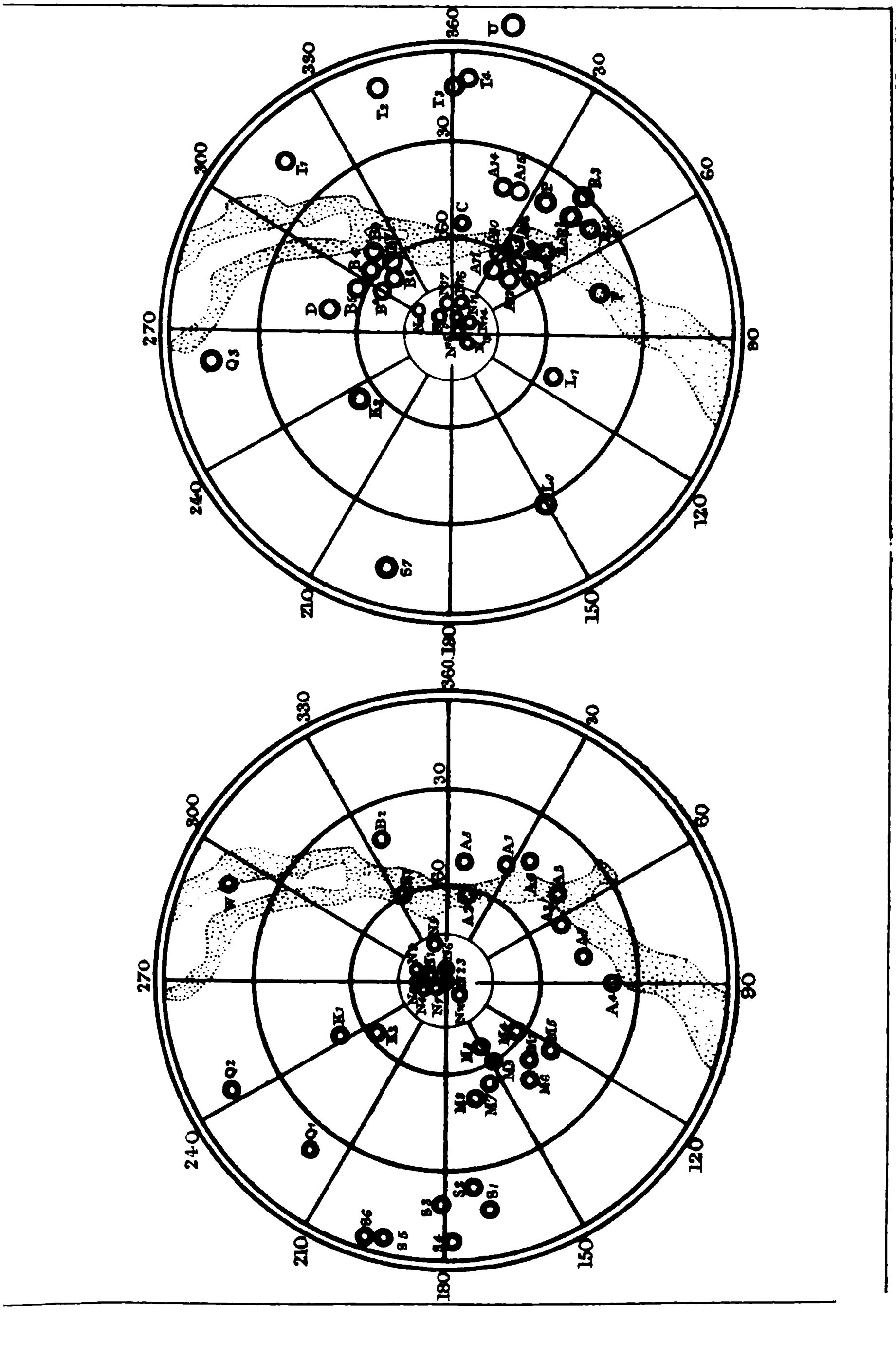

General Plan of
TROISKY PAPER MILL,
ON RIVER SCHAN,
nr. Town of Medin,
in Government of Kalanga,
RUSSIA.
BELONGING TO
W. HOWARD ESQR. & Co.
Road
700 ft
PINE WOOD
PINE WOOD
Road
d
d
d
RIVER
SCHAN
TROISKY MILL
ROAD
SCALE OF FEET.
0
700
1400

PLATE XXVII.


270
240
300
210
330
180
360
150
30
120
60
90
XIX
SG2
XX
Q1
XVI
Q.G
XXI
W
XVII
DG1
XX
Q
XVIII a
D
XVIII
DG2
XII
MG1
I
XIV
S5
XI
M7,8
XXIII
B1,2
XXII
VIII
S1,2,3
V
M
IV
VII
III
AG1
VIIIa
SG1
IX
M5,6
VI
M4
XV
XIII
II
XXVII
XXVIIa
Q3
XXVII
T1
XLV
DG5
XXIX
N12,13
XLVI
KG
XLII
Lo
XXXVII
LG
XL
F
XLIV
A16
XXXV
AG2
XXXVIII
R3
XXXIV
T9
XLIII
LH
XLVIII
G
XXXIX
O
XLI
AG3
XXXb
XXXI
R1,2
E



PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

EDITED BY

JAMES GLAISHER, Esq., F.R.S., Secretary.

Vol. II. 1865, FEBRUARY 15. [No. 17.

S. C. WHITBREAD, Esq., F.R.S., President, in the Chair.

A. S. Bartley, Esq., M.D., Assistant Surgeon, 101st Regiment, Dugshai, Bengal;
Rogus Field, Esq., B.A., 18 Manchester Buildings, Westminster.
Lieut. F. Gallwey, R.A., Shoeburyness, Essex;
Fred. Moser, Esq., Mudieford House, Christchurch, Hants;
Capt. J. Sprot, 83rd Regiment, Chatham;
William Henry Valpy, Esq., M.D., 18 Grosvenor Crescent, London;
were balloted for and duly elected Members of the Society.

The names of Three Candidates for admission into the Society were read.

LXXXII. *On the Mean Temperature of every Day, from all Thermometrical Observations taken at the Royal Observatory, Greenwich, from the year* 1814 *to the end of* 1863. By James Glaisher, Esq., F.R.S.

In the Annual Report of this Society for the year 1857, the daily results of all the thermometrical observations taken at the Royal

Observatory, Greenwich, in the years 1814 to 1856, were published, and have since been used in determining the departures daily of observed mean temperatures from the average values there found. At the end of the year 1863 the number of years of continuous observations amounted to fifty, and it seemed important to combine these with the series ending 1856 at once, as the seven years were of a very different character to those at the beginning of the series, and exhibited still greater differences when compared, month by month, with those made at the end of the last century.

The series from 1857 was a continuance of that beginning 1848, viz. daily observations of thermometers with their bulbs 4 feet above the soil, taken at 9 A.M., noon, 3 P.M., and 9 P.M., to the means of which the proper corrections for daily range have been applied by the use of the factors contained in my Tables (Phil. Trans. 1848), the monthly average value of the daily corrections amounting to $-0^{\circ}\cdot9$ in January, $-1^{\circ}\cdot3$ in February, $-2^{\circ}\cdot2$ in March, $-3^{\circ}\cdot4$ in April, $-3^{\circ}\cdot4$ in May, $-4^{\circ}\cdot1$ in June, $-3^{\circ}\cdot2$ in August, $-2^{\circ}\cdot9$ in September, $-1^{\circ}\cdot9$ in October, $-1^{\circ}\cdot2$ in November, $-0^{\circ}\cdot7$ in December. During those several years the photographic registration of temperature was continuous, and the accuracy of all readings have been thus confirmed.

The mean temperature of every day was also determined by the use of the maximum and minimum thermometers, by the application of the correction as found in my Table of Diurnal Range, as due to each month, viz. January, $0^{\circ}\cdot2$; February, $0^{\circ}\cdot4$; March, $1^{\circ}\cdot0$; April, $1^{\circ}\cdot5$; May, $1^{\circ}\cdot7$; June, $1^{\circ}\cdot8$; July, $1^{\circ}\cdot9$; August, $1^{\circ}\cdot7$; September, $1^{\circ}\cdot3$; October, $1^{\circ}\cdot0$; November, $0^{\circ}\cdot4$; and December, $0^{\circ}\cdot0$; all applied subtractively to the simple arithmetical mean of the readings of the maximum and minimum thermometers, to deduce from them the approximate mean temperature of the air.

Then the adopted mean daily temperature has been found by giving double the weight to the determination from the four observations taken during the day to that deduced by the maximum and minimum thermometers, or, in other words, combining the results found by each method, according to the number of observations on which each was based; and in this way the numbers in the following Tables have been formed.

Some time since J. Park Harrison, Esq., drew my attention to the fact that the numbers in the column headed December 1814, and January 1815, were identical; and on examination it was found

that the numbers really belonged to January 1815, but that those in December 1814 were wrong, and should be as follows:—

1814, December	1	was	37·6	and the mean of 43 years was		42·5
"	2	"	37·3	"	"	41·9
"	3	"	32·6	"	"	40·8
"	4	"	39·3	"	"	41·7
"	5	"	36·9	"	"	42·6
"	6	"	33·6	"	"	41·5
"	7	"	38·7	"	"	41·5
"	8	"	48·6	"	"	41·1
"	9	"	44·9	"	"	40·4
"	10	"	36·9	"	"	40·1
"	11	"	49·3	"	"	39·3
"	12	"	54·6	"	"	40·1
"	13	"	51·9	"	"	40·0
"	14	"	48·6	"	"	40·8
"	15	"	50·6	"	"	40·7
"	16	"	48·6	"	"	40·4
"	17	"	49·6	"	"	40·1
"	18	"	53·9	"	"	40·9
"	19	"	48·3	"	"	39·8
"	20	"	36·3	"	"	40·0
"	21	"	34·3	"	"	38·6
"	22	"	32·1	"	"	38·1
"	23	"	33·6	"	"	37·6
"	24	"	30·6	"	"	37·5
"	25	"	30·1	"	"	36·9
"	26	"	32·9	"	"	36·0
"	27	"	35·3	"	"	36·8
"	28	"	37·6	"	"	36·4
"	29	"	43·3	"	"	36·7
"	30	"	47·3	"	"	38·7
"	31	"	39·3	"	"	37·9

And these numbers should be substituted in all copies for those printed in the Annual Report for the year 1857. Thus the numbers in the following Tables have been formed:—

Table I.—January.

Mean Temperature of every day in the month of January, as deduced from the observations taken on that day, at the Royal Observatory, Greenwich, in the fifty years ending 1863; and Extremes of Mean Temperature for every day within the same period.

Days of the Month.	Mean of Temp. of 43 Years.	Mean Daily Temperature of the Air.							Mean of Temp. of 50 Years.	Lowest and Highest Mean Daily Temperature in 50 Years.				Diff. between the Coldest and Hottest Day.
		1857.	1858.	1859.	1860.	1861.	1862.	1863.		Lowest.	Year.	Highest.	Year.	
	°	°	°	°	°	°	°	°	°	°		°		°
1	36·9	47·9	40·0	43·1	52·2	39·9	33·3	48·3	37·83	19·9	1820	52·2	1860	32·3
2	35·9	43·9	40·4	33·8	47·7	29·0	37·1	42·0	36·35	22·1	1836	49·9	1851	27·8
3	35·8	45·3	35·5	33·3	49·8	28·7	35·4	40·2	36·15	22·1	1827	49·8	1860	27·7
4	36·8	39·7	30·8	38·9	43·0	28·0	36·5	42·4	36·83	23·0	1827	48·9	1817	25·9
5	35·9	32·3	27·6	40·2	39·7	27·5	39·0	44·9	35·90	22·6	1820	50·6	1844	28·0
6	36·8	32·7	25·4	34·0	37·5	23·6	33·0	42·3	36·22	23·6	1861	48·3	1855	24·7
7	36·2	31·5	31·2	34·9	34·8	26·4	38·9	36·4	35·81	17·4	1841	47·1	1855	29·7
8	34·9	33·7	44·6	32·9	40·4	24·5	44·1	39·4	35·21	12·8	1841	48·5	1827	35·7
9	34·9	42·4	46·0	33·6	34·9	25·0	49·7	36·8	35·38	20·9	1838 and 1841	49·7	1862	28·8
10	35·6	45·3	46·4	37·1	44·4	21·7	47·8	37·8	36·03	19·6	1814	48·7	1818	29·1
11	35·5	41·7	41·9	44·2	38·0	28·7	47·7	38·1	36·14	21·0	1838	48·2	1851	27·2
12	35·9	36·4	38·0	45·0	39·1	34·8	43·6	36·9	36·35	16·8	1838	50·7	1818	33·9
13	36·8	33·5	39·7	40·1	36·0	31·0	39·2	40·8	36·85	18·7	1820	49·3	1849	30·6
14	36·1	32·3	35·3	35·2	42·5	28·0	40·2	37·1	36·06	16·2	1815	49·6	1819	33·4
15	34·8	35·7	36·5	38·3	45·9	27·6	35·9	38·8	36·10	14·6	1820	50·7	1818	34·1
16	36·1	37·8	40·6	34·7	38·8	26·9	32·1	38·1	36·02	18·9	1826	49·4	1818	30·5
17	36·7	38·4	34·6	45·0	36·0	33·5	27·0	37·0	36·59	22·3	1830	50·3	1849	28·0
18	36·7	44·5	38·3	50·5	32·9	32·9	26·8	39·7	36·87	18·1	1830	51·1	1828	33·0
19	36·7	42·4	41·6	43·4	40·2	33·8	25·3	45·2	37·00	13·4	1823	49·9	1849	36·5
20	36·2	38·1	44·1	42·0	42·8	39·5	28·0	41·3	36·65	10·7	1838	49·6	1853	38·9
21	36·6	32·2	35·3	44·2	39·9	39·9	30·5	41·9	36·75	22·2	1814	48·9	1840	26·7
22	37·5	35·1	34·5	43·0	40·2	35·6	40·9	47·8	37·79	22·6	1820	51·4	1846	28·8
23	37·3	37·7	34·2	41·2	40·0	36·3	39·6	46·4	37·58	21·1	1829	51·8	1834	30·7
24	37·7	36·4	32·2	41·1	39·7	40·6	48·0	44·4	38·06	20·9	1815	52·7	1834	31·8
25	37·7	35·9	32·9	48·0	37·9	48·5	40·7	43·3	38·17	22·8	1829	51·4	1824	28·6
26	38·8	33·1	29·6	41·4	35·7	46·8	38·1	45·6	38·77	25·1	1848	51·0	1834	25·9
27	38·4	31·8	36·2	45·1	42·7	47·1	40·6	41·9	38·73	26·5	1848	50·7	1843	24·2
28	37·9	29·7	38·7	43·8	32·6	41·7	42·7	39·2	37·96	21·0	1848	52·3	1843	31·3
29	37·7	26·2	44·7	45·0	40·1	40·6	48·5	48·0	38·28	26·2	1857	49·6	1843	23·4
30	37·9	28·5	48·3	41·2	39·8	37·8	48·0	49·0	38·45	23·6	1816	49·3	1854	25·7
31	37·6	32·9	37·8	38·1	37·0	43·8	52·1	44·4	38·10	20·0	1830	52·1	1862	32·1
Means	36·6	36·6	37·5	40·4	39·7	33·8	39·0	41·8	36·93					

The mean temperature of the coldest day in January, in fifty years, was 10°·7, on the 20th day in the year 1838.

The mean temperature of the hottest day in January, in fifty years, was 52°·7, on the 24th day in the year 1834.

The difference between these numbers is 42°·0, and it represents the extreme difference between the mean temperature of two days in the month of January in fifty years.

The day of the month whose mean temperature has been subjected to the greatest difference, 38°·9, was the 20th; and that to the least, 24°·0, was the 5th.

TABLE II.—FEBRUARY.

Mean Temperature of every day in the month of February, as deduced from the observations taken on that day, at the Royal Observatory, Greenwich, in the fifty years ending 1863; and Extremes of Mean Temperature for every day within the same period.

Days of the Month.	Mean of Temp. of 43 Years.	Mean Daily Temperature of the Air.							Mean of Temp. of 50 Years.	Lowest and Highest Mean Daily Temperature in 50 Years.				Diff. between the Coldest and Hottest Day.
		1857.	1858.	1859.	1860.	1861.	1862.	1863.		Lowest.	Year.	Highest.	Year.	
	°	°	°	°	°	°	°	°	°	°		°		°
1	37·0	24·5	32·0	39·8	32·0	46·4	50·9	42·3	37·18	22·0	1830	50·9	1862	28·9
2	37·1	30·3	29·5	42·6	33·1	38·6	49·0	46·1	37·29	17·0	1830	52·2	1850	35·2
3	37·2	28·2	37·9	34·5	34·8	39·6	50·3	43·7	37·37	19·2	1830 and 1841	50·3	1862	31·1
4	37·5	29·0	44·2	39·6	37·3	41·7	51·0	42·1	37·95	22·0	1814	51·2	1862	29·2
5	38·5	30·8	43·4	41·7	44·9	44·2	49·0	47·0	39·13	19·0	1830	51·6	1852	32·6
6	38·6	42·2	40·1	40·2	37·3	45·7	42·4	47·7	39·07	18·7	1830	51·1	1854	32·4
7	39·9	41·2	35·4	37·9	36·6	44·0	32·4	48·5	39·83	27·7	1818	49·7	1856	22·0
8	39·5	40·4	31·7	39·0	44·5	43·9	28·1	41·7	39·47	19·7	1816	50·7	1831	31·0
9	38·9	42·8	32·0	44·2	33·9	41·0	32·3	37·2	38·72	12·6	1816	55·0	1831	42·4
10	38·5	43·9	31·8	44·5	28·5	37·0	34·4	43·3	38·38	22·6	1816	51·7	1831	29·1
11	38·2	44·4	31·2	44·9	31·0	31·9	34·6	43·0	38·07	24·5	1845	47·9	1842	23·4
12	37·9	38·7	37·4	45·8	31·0	30·2	40·3	43·1	37·92	19·2	1845	49·1	1842	29·9
13	37·6	37·9	40·4	45·9	27·7	36·1	36 6	38·5	37·60	24·8	1847	48·0	1848	23·2
14	38·1	38·4	36·7	43·0	29·4	36·2	36·8	37·9	37·93	24·5	1855	50·3	1848	25·8
15	38·6	36·9	36·0	43·5	33·5	44·5	38·5	38·3	38·62	24·8	1843	53·0	1850	28·2
16	38·2	41·9	37·3	50·3	35·6	47·2	36 8	37·9	38·59	24·5	1855	50·3	1859	25·8
17	37·1	44·5	35·6	49·6	37·4	46·4	39·1	39·3	37·74	23·3	1827	51·1	1852	27·8
18	38·2	45·9	30·8	42·6	40·0	45·5	47·4	36·3	38·58	21·1	1855	49·3	1847	28·2
19	38·4	42·3	30·0	40·6	39·1	45·5	49·6	41·2	38·79	23·3	1855	49·6	1862	26·3
20	37·7	43·1	31·6	46·0	33·4	42·6	50·0	40·2	38·16	25·8	1855	50·0	1862	24·2
21	38·7	42·5	33·3	46·9	36·1	48·6	47·5	39·8	39·18	24·8	1855	48·6	1846 and 1861	23·8
22	39·4	45·3	33·1	46·6	35·5	49·9	47·4	42·7	39·89	26·8	1855	50·7	1849	23·9
23	39·7	44·4	35·1	41·5	31·8	45·6	45·2	41·7	39·85	26·1	1814	51·8	1846	25 7
24	39·1	40·9	35·4	42·7	31·5	41·9	38·3	42·8	39·09	25·5	1814	53·4	1846	27·9
25	40·1	33·6	31·4	42·0	33·8	41·0	38·1	43·5	39·75	24·1	1814	50·6	1846	26·5
26	39·4	38·7	30·3	42·8	44·6	41·8	33·6	45·4	39·43	26·5	1814	50·7	1828	24·2
27	39·5	40·2	33·0	45·2	39·7	40·2	34·2	45·1	39·52	25·6	1821	52·1	1846	26·5
28	39·4	45·6	32·3	43·3	42·3	44·5	35·9	42·6	39·61	29·2	1820	52·4	1846	23·2
Means	38·6	39·2	34·6	43·1	38·2	42·1	41·1	42·1	38 67					

The mean temperature of the coldest day in February, in fifty years, was 12°·6, on the 9th day in the year 1816.

The mean temperature of the hottest day in February, in fifty years, was 55°·0, on the 9th day in the year 1831.

The difference between these numbers is 42°·4, and it represents the extreme difference between the mean temperature of two days in the month of February in fifty years.

The day of the month whose mean temperature has been subjected to the greatest difference, 42°·4, was the 9th; and that to the least, 22°·0, was the 7th.

TABLE III.—MARCH.

Mean Temperature of every day in the month of March, as deduced from the observations taken on that day, at the Royal Observatory, Greenwich, in the fifty years ending 1863; and Extremes of Mean Temperature for every day within the same period.

Days of the Month.	Mean of Temp. of 43 Years.	Mean Daily Temperature of the Air.							Mean of Temp. of 50 Years.	Lowest and Highest Mean Daily Temperature in 50 Years.				Diff. between the Coldest and Hottest Day.
		1857.	1858.	1859.	1860.	1861.	1862.	1863.		Lowest.	Year.	Highest.	Year.	
	°	°	°	°	°	°	°	°	°	°		°		°
1	39·7	43·0	29·6	46·9	39·5	44·9	36·6	43·5	39·82	29·3	1829	49·7	1827	20·4
2	40·7	43·9	29·4	45·8	40·0	43·4	31·1	48·5	40·64	29·4	1858	51·1	1834	21·7
3	41·0	43·2	29·6	51·0	41·3	46·2	30·3	50·6	41·12	29·6	1858	51·2	1842	21·6
4	39·9	43·1	33·3	54·8	41·4	41·0	29·9	49·8	40·18	27·2	1845	54·8	1859	27·6
5	39·0	38·1	33·1	52·0	40·1	41·4	35·5	48·1	39·31	26·3	1845	52·0	1859	25·7
6	39·5	46·1	32·9	49·9	37·9	48·6	48·3	48·0	40·20	24·5	1845	49·9	1859	25·4
7	39·7	43·0	33·1	49·8	33·7	44·9	51·9	42·4	40·14	26·5	1839	51·9	1862	25·4
8	39·8	35·8	31·1	40·5	35·0	50·3	53·3	39·9	40·55	28·5	1814	53·3	1862	24·8
9	40·3	35·4	33·2	38·7	33·2	43·9	47·2	37·4	40·02	27·8	1839	56·3	1826	28·5
10	39·9	34·5	35·3	40·8	30·9	46·7	46·4	36·9	39·74	27·7	1855	54·1	1826	26·4
11	40·8	33·3	32·4	46·6	35·6	40·6	46·1	35·4	40·49	27·8	1847	51·6	1830	23·8
12	41·4	36·8	32·6	53·5	37·6	40·8	46·5	36·2	41·28	31·3	1814	53·5	1859	22·2
13	41·8	38·4	44·9	52·2	39·3	40·7	44·9	40·4	41·96	22·1	1845	52·2	1859	30·1
14	41·8	46·2	42·8	50·6	40·5	41·7	41·8	40·5	42·03	23·2	1845	52·8	1828	29·6
15	41·5	41·7	45·8	44·2	38·1	45·5	41·5	39·7	41·62	26·8	1845	52·9	1822	26·1
16	42·3	44·0	50·8	48·3	42·3	40·8	41·5	40·5	42·54	31·1	1814	54·3	1828	23·2
17	41·5	44·4	48·3	47·6	48·3	38·0	41·7	39·0	41·84	28·5	1845	51·9	1822	23·4
18	41·0	53·2	48·5	45·2	46·2	40·2	41·8	36·0	41·48	28·5	1853	53·2	1857	24·7
19	41·7	50·7	49·5	43·7	44·9	42·0	41·1	40·3	42·10	28·5	1814	54·6	1822	26·1
20	42·5	44·9	50·3	46·4	46·5	42·0	36·1	46·1	42·80	30·6	1817	58·0	1836	27·4
21	42·0	35·7	47·4	42·1	43·7	39·4	34·7	45·1	41·88	27·2	1337	52·1	1843	24·9
22	42·3	32·9	46·1	40·8	39·8	42·3	37·7	45·5	42·08	29·6	1817	54·2	1852	24·6
23	41·9	35·6	49·0	44·5	40·8	45·1	39·9	48·3	42·10	32·2	1837	53·3	1852	21·1
24	41·3	40·2	54·8	48·4	39·8	48·9	53·3	50·6	42·24	29·0	1837	54·8	1858	25·8
25	40·6	40·2	42·5	51·2	42·0	42·8	53·8	47·8	41·32	32·2	1853	53·8	1862	21·6
26	41·7	41·1	42·6	49·6	40·3	47·5	48·1	48·4	42·21	31·2	1850	56·3	1830	25·1
27	43·0	41·5	43·5	48·8	41·6	49·2	50·7	45·4	43·39	31·2	1837	54·1	1830	22·9
28	43·5	46·0	46·7	49·6	50·0	46·4	45·9	50·1	44·10	34·5	1850	56·2	1822	21·7
29	43·3	47·1	49·0	47·4	50·6	45·0	43·5	51·6	43·92	36·4	1855	53·8	1830	17·4
30	44·2	48·3	48·2	35·3	45·4	43·4	46·1	45·0	44·26	35·3	1859	51·6	1848	16·3
31	43·8	47·4	48·1	34·0	47·2	43·1	48·8	43·5	43·89	31·8	1824	58·6	1815	26·8
Means	41·4	41·8	41·4	46·4	41·1	43·8	43·1	43·9	41·65					

The mean temperature of the coldest day in March, in fifty years, was 22°·1, on the 13th day in the year 1845.

The mean temperature of the hottest day in March, in fifty years, was 58°·6, on the 31st day in the year 1815.

The difference between these numbers is 36°·5, and it represents the extreme difference between the mean temperature of two days in the month of March in fifty years.

The day of the month whose mean temperature has been subjected to the greatest difference, 30°·1, was the 13th; and that to the least, 16°·3, was the 30th.

TABLE IV.—APRIL.

Mean Temperature of every day in the month of April, as deduced from the observations taken on that day, at the Royal Observatory, Greenwich, in the fifty years ending 1863; and Extremes of Mean Temperature for every day within the same period.

Days of the Month.	Mean of Temp. of 43 Years.	Mean Daily Temperature of the Air.							Mean of Temp. of 50 Years.	Lowest and Highest Mean Daily Temperature in 50 Years.				Diff. between the Coldest and Hottest Day.
		1857.	1858.	1859.	1860.	1861.	1862.	1863.		Lowest.	Year.	Highest.	Year.	
	°	°	°	°	°	°	°	°	°	°		°		°
1	43·8	47·0	38·4	37·3	47·0	41·5	48·1	41·2	43·68	27·8	1836	57·0	1848	29·2
2	44·3	48·7	34·7	45·6	38·8	43·3	51·9	43·6	44·27	32·4	1839	61·8	1848	29·4
3	44·2	48·8	37·3	52·3	44·1	45·2	50·3	46·2	44·68	28·9	1839	60·7	1848	31·8
4	44·4	47·6	43·1	56·0	43·4	47·1	46·0	46·0	44·77	29·5	1839	61·3	1848	31·8
5	44·9	55·3	39·7	55·6	46·1	44·0	48·9	45·3	45·31	29·7	1839	55·6	1859	25·9
6	45·5	53·8	38·9	61·1	48·0	40·2	50·6	50·5	45·99	34·0	1839	61·1	1859	27·1
7	45·7	50·7	39·3	63·0	52·2	42·1	47·4	46·0	46·12	34·0	1837	63·0	1859	29·0
8	45·6	51·0	44·5	52·9	49·0	41·1	43·2	45·0	45·75	34·4	1839	56·2	1821	21·8
9	44·4	49·7	37·1	53·3	40·8	41·7	43·2	51·8	44·54	31·7	1837	54·5	1815	22·8
10	44·7	48·1	39·4	49·3	39·3	42·7	45·9	55·6	44·85	30·4	1837	55·6	1863	25·2
11	44·4	40·7	39·2	47·0	37·1	45·6	39·6	52·5	44·22	31·7	1837	54·4	1838	22·7
12	45·2	40·8	37·9	43·1	40·5	49·4	36·6	50·7	44·85	33·9	1837	54·9	1828	21·0
13	45·0	36·8	39·6	40·4	40·9	46·7	35·8	48·7	44·48	31·4	1837	57·0	1814	25·6
14	46·4	40·9	44·7	42·2	37·6	44·2	37·8	46·4	45·78	31·5	1816	57·7	1852	26·2
15	46·5	40·4	55·5	37·4	44·5	45·2	39·2	50·9	46·25	36·5	1816	58·7	1814	22·2
16	46·1	40·8	60·1	37·5	46·3	49·9	41·7	54·8	46·27	33·5	1835	60·1	1858	16·6
17	45·6	46·5	49·8	37·5	44·9	46·0	48·6	52·2	45·72	33·1	1837	55·8	1820	22·7
18	45·7	57·4	47·8	38·2	45·0	46·6	48·8	50·6	46·71	33 0	1838	57·4	1857	24·4
19	46·0	56·4	49·8	39·9	37·3	44·9	52·3	48·8	46·15	32·4	1849	58·2	1854	25·8
20	47·4	53·1	52·6	42·7	39·6	41·3	53·3	51·8	47·45	33·9	1838	59·9	1854	26·0
21	47·6	50·3	55·0	43·5	38·7	40·2	52·6	48·8	47·52	36·8	1849	58·2	1854	21·4
22	48·0	47·0	56·2	42·5	38·0	44·1	51·7	51·6	47·90	38·0	1837 and 1860	56·2	1858	18·2
23	48·1	40·1	54·2	42·4	39·9	45·1	50·7	47·6	47·77	36·4	1827	58·5	1821	22·1
24	47·4	38·6	54·3	45·6	36·6	46·3	54·0	49·0	47·25	36·6	1860	59·5	1821	22·9
25	46·9	40·5	49·6	49·8	44·4	39·5	60·2	53·9	47·29	37·9	1829	63·2	1821	25·3
26	47·9	37·0	48·2	52·6	43·6	48·9	56·8	53·0	48·00	37·0	1857	63·2	1821	26·2
27	47·4	39·8	44·0	45·2	42·3	36·2	53·8	54·4	47·48	36·2	1861	63·5	1841	27·3
28	48·2	40·4	51·4	46·8	43·4	40·8	54·2	47·8	47·95	39·4	1838	61·0	1840	21·6
29	48·9	41·0	48·8	53·7	42·4	43·1	53·6	43·4	48·69	35·4	1836	61·7	1840	26·3
30	49·7	41·6	44·6	44·1	50·4	46·4	55·2	43·4	49·26	38·4	1836	61·4	1830	23·0
Means	46·2	45·7	46·2	46·6	42·9	44·3	48·4	49·1	46·23					

The mean temperature of the coldest day in April, in fifty years, was 27°·8, on the 1st day in the year 1836.

The mean temperature of the hottest day in April, in fifty years, was 63°·5, on the 27th day in the year 1861.

The difference between these numbers is 35°·7, and it represents the extreme difference between the mean temperature of two days in the month of April in fifty years.

The days of the month whose mean temperature has been subjected to the greatest difference, 31°·8, were the 3rd and 4th; and that day to the least, 16°·6, was the 16th.

TABLE V.—MAY.

Mean Temperature of every day in the month of May, as deduced from the observations taken on that day, at the Royal Observatory, Greenwich, in the fifty years ending 1863; and Extremes of Mean Temperature for every day within the same period.

Days of the Month.	Mean of Temp. of 43 Years.	Mean Daily Temperature of the Air.							Mean of Temp. of 50 Years.	Lowest and Highest Mean Daily Temperature in 50 Years.				Diff. between the Coldest and Hottest Day.
		1857.	1858.	1859.	1860.	1861.	1862.	1863.		Lowest.	Year.	Highest.	Year.	
	°	°	°	°	°	°	°	°	°	°		°		°
1	50·3	44·5	43·1	45·3	53·1	50·2	61·1	44·4	50·09	40·4	1856	62·8	1827	22·4
2	51·5	46·4	42·5	46·7	54·8	50·4	52·4	48·0	51·11	40·3	1856	59·8	1838	19·5
3	50·9	42·3	45·9	47·4	52·4	50·0	44·7	54·0	50·51	36·2	1832	60·8	1819	24·6
4	51·5	42·6	43·6	48·8	51·3	53·3	49·8	56·4	51·21	40·2	1851	66·3	1834	26·1
5	51·8	42·8	48·6	47·1	45·7	52·9	62·7	55·7	51·46	40·6	1856	62·7	1862	22·1
6	51·9	44·8	48·2	47·8	43·7	46·2	65·4	54·4	51·64	39·7	1831	66·1	1830	26·4
7	52·3	44·1	44·8	56·4	48·6	42·1	55·9	53·1	51·88	38·0	1853	66·3	1830	28·3
8	52·1	47·0	45·5	52·4	42·8	39·9	54·6	47·3	51·62	40·1	1853	63·2	1838	23·1
9	51·0	50·1	46·9	50·3	43·3	43·8	51·5	51·8	50·82	38·2	1837	63·2	1834	25·0
10	50·9	47·9	52·8	47·4	42·7	44·2	52·6	52·6	50·78	41·4	1816	61·1	1848	19·7
11	51·6	56·2	49·8	52·5	56·3	44·4	51·9	52·7	51·61	41·5	1837	63·7	1848	22·2
12	51·3	54·9	45·8	51·0	58·3	52·1	51·4	51·4	51·42	38·1	1816	67·3	1833	29·2
13	51·0	58·6	49·1	52·0	55·2	45·1	50·5	55·0	51·17	40·8	1816	64·9	1848	24·1
14	50·6	58·5	50·9	52·7	54·1	51·5	50·0	53·3	50·94	34·5	1839	66·1	1848	31·6
15	51·9	62·5	52·2	52·6	56·6	57·7	46·9	53·6	52·28	42·0	1855	72·4	1833	30·4
16	53·1	64·6	53·0	52·8	51·9	61·1	55·7	53·3	53·51	40·2	1839	68·0	1833	27·8
17	54·0	61·6	52·5	50·3	53·2	48·7	57·2	52·5	53·98	45·5	1832	72·2	1833	26·7
18	53·5	62·6	54·8	41·6	54·2	46·8	58·5	51·8	53·62	43·7	1844	62·6	1830 and 1857	18·9
19	53·0	59·8	53·5	54·9	55·3	46·9	60·6	44·0	53·08	42·8	1840	60·8	1822	18·0
20	53·9	58·9	55·6	54·0	59·5	57·5	58·0	46·5	54·15	39·8	1837	63·6	1822	23·8
21	53·7	59·9	59·5	52·3	60·3	62·9	48·2	49·3	54·03	43·7	1837	63·9	1822	20·2
22	53·2	52·8	55·3	49·8	61·4	60·4	51·0	45·3	53·27	40·4	1837	63·1	1847	22·7
23	54·4	56·7	53·0	52·2	60·6	64·9	55·1	47·8	54·59	42·8	1821	64·9	1861	22·1
24	54·8	56·3	55·4	45·9	59·3	55·0	37·9	50·3	54·93	41·4	1814	63·2	1833	21·8
25	54·9	49·3	51·0	58·3	55·9	54·7	54·7	48·7	54·87	42·5	1839	66·2	1833	23·7
26	54·8	55·6	49·9	49·6	56·3	54·3	55·6	47·7	54·71	40·1	1821	66·2	1841	26·1
27	55·0	57·1	54·8	59·0	50·4	58·5	56·1	55·5	55·13	44·8	1821	68·6	1841	23·8
28	55·4	58·2	54·8	58·0	49·0	52·2	59·1	59·4	55·46	44·5	1833	72·2	1847	27·7
29	54·6	55·6	59·1	60·2	48·7	58·0	60·9	63·5	55·08	45·7	1855	64·3	1848	18·6
30	55·1	55·9	63·2	64·3	43·1	62·8	59·1	62·5	55·80	43·7	1855	66·1	1841	22·4
31	56·2	56·2	67·7	61·4	49·7	60·1	57·4	52·1	56·42	45·4	1855	67·7	1858	22·3
Means	53·0	54·0	51·7	53·1	53·8	51·9	55·4	52·0	52·94					

The mean temperature of the coldest day in May, in fifty years, was 36°·2, on the 3rd day in the year 1832.

The mean temperature of the hottest day in May, in fifty years, was 72°·4, on the 15th day in the year 1833.

The difference between these numbers is 36°·2, and it represents the extreme difference between the mean temperature of two days in the month of May in fifty years.

The day of the month whose mean temperature has been subjected to the greatest difference, 31°·6, was on the 14th; and that to the least, 18°·0, was the 19th.

TABLE VI.—JUNE.

Mean Temperature of every day in the month of June, as deduced from the observations taken on that day, at the Royal Observatory, Greenwich, in the fifty years ending 1863; and Extremes of Mean Temperature for every day within the same period.

Days of the Month.	Mean of Temp. of 43 Years.	Mean Daily Temperature of the Air.							Mean of Temp. of 50 Years.	Lowest and Highest Mean Daily Temperature in 50 Years.				Diff. between the Coldest and Hottest Day.
		1857.	1858.	1859.	1860.	1861.	1862.	1863.		Lowest.	Year.	Highest.	Year.	
	°	°	°	°	°	°	°	°	°	°		°		°
1	56·8	54·2	70·7	60·3	55·4	56·4	59·9	52·4	57·03	48·0	1855	70·7	1858	22·7
2	57·5	56·8	68·1	61·8	52·7	54·4	59·7	59·4	57·71	49·6	1837 and 1840	68·9	1834	19·3
3	57·3	57·1	70·0	62·3	52·7	53·4	58·9	66·5	57·70	47·2	1837	70·0	1858	22·8
4	56·3	64·5	64·2	65·6	53·7	53·8	57·5	62·1	56·85	47·7	1851	67·8	1818	20·1
5	57·0	67·3	59·4	63·5	52·5	55·4	53·7	54·3	57·14	46·0	1814	68·5	1822	22·5
6	56·5	68·4	60·3	60·7	50·1	51·3	59·1	53·9	56·67	46·0	1814	71·4	1855	25·4
7	56·6	62·2	59·3	62·2	49·6	52·9	61·7	56·5	56·76	45·0	1814	70·9	1846	25·9
8	57·4	58·0	63·8	64·6	53·3	52·1	57·7	53·6	57·47	45·9	1838	70·1	1835	24·2
9	58·0	56·6	68·5	61·5	51·2	51·2	55·3	54·6	57·86	43·5	1816	70·1	1822	26·6
10	57·5	54·4	63·7	58·7	51·9	55·8	54·1	57·0	57·36	46·1	1816	72·1	1822	26·0
11	58·5	54·4	65·1	60·8	54·2	58·0	57·8	54·4	58·40	49·1	1821	72·1	1835	23·0
12	58·7	53·1	66·1	61·0	54·0	60·1	54·2	51·6	58·48	48·8	1821	73·5	1818	24·7
13	59·0	53·5	66·9	64·0	53·9	64·3	56·1	54·9	59·01	49·1	1821	76·1	1818	27·0
14	59·7	54·2	72·0	56·3	53·2	67·0	52·2	57·1	59·58	50·0	1830	72·0	1858	22·0
15	59·1	56·3	73·8	60·8	53·0	66·9	55·7	60·1	59·36	48·0	1830	73·8	1858	25·8
16	58·7	57·5	76·9	57·4	57·0	63·2	55·6	57·3	58·98	48·8	1816	76·9	1858	28·1
17	58·7	60·8	64·9	57·3	50·8	58·9	56·6	59·9	58·67	46·6	1832	68·2	1846	21·6
18	58·6	59·2	56·7	60·9	56·6	60·2	54·0	59·4	58·54	48·7	1823	72·6	1839	23·9
19	59·1	65·2	62·6	60·6	53·7	65·1	53·7	57·3	59·19	51·5	1855	70·5	1817	19·0
20	59·2	69·1	62·7	57·3	58·6	64·7	54·1	60·3	59·45	50·7	1855	71·2	1846	20·5
21	59·9	67·9	63·3	56·4	57·6	63·9	54·7	60·6	60·00	50·0	1825	75·8	1817	25·8
22	59·4	60·8	68·4	64·9	58·1	64·5	55·4	59·7	59·72	49·7	1814	72·8	1846	23·1
23	60·8	66·6	68·3	60·7	60·5	61·7	56·4	65·1	61·07	49·4	1814	68·3	1858	18·9
24	60·9	68·2	60·9	58·5	62·6	62·3	57·9	63·1	61·04	48·8	1835	71·3	1844	22·5
25	61·5	67·5	61·1	61·9	57·4	56·3	55·4	62·0	61·32	45·1	1835	71·5	1820	26·4
26	61·9	69·1	66·6	69·0	57·3	57·8	60·3	60·1	62·04	47·1	1835	73·1	1820	26·0
27	61·8	71·0	59·6	68·5	56·0	58·5	55·2	57·7	61·66	47·6	1835	74·8	1818	27·2
28	62·4	73·7	60·8	63·1	53·6	61·8	52·8	57·3	62·21	51·8	1831	74·2	1826	22·4
29	61·5	65·2	59·6	60·5	55·8	62·2	57·5	57·4	61·26	46·7	1839	70·2	1826	23·5
30	61·8	61·7	63·4	61·4	53·0	57·4	56·5	56·9	61·36	47·7	1839	70·6	1826	22·9
Means	59·1	61·8	64·9	61·4	54·8	59·1	56·3	58·1	59·13					

The mean temperature of the coldest day in June, in fifty years, was 45°·0, on the 7th day in the year 1814.

The mean temperature of the hottest day in June, in fifty years, was 76°·9, on the 16th day in the year 1858.

The difference between these numbers is 31°·9, and it represents the extreme difference between the mean temperature of two days in the month of June in fifty years.

The day of the month whose mean temperature has been subjected to the greatest difference, 28°·1, was the 16th; and that to the least, 18°·9, was the 23rd.

Table VII.—July.

Mean Temperature of every day in the month of July, as deduced from the observations taken on that day, at the Royal Observatory, Greenwich, in the fifty years ending 1863; and Extremes of Mean Temperature for every day within the same period.

Days of the Month.	Mean of Temp. of 43 Years.	Mean Daily Temperature of the Air.							Mean of Temp. of 50 Years.	Lowest and Highest Mean Daily Temperature in 50 Years.				Diff. between the Coldest and Hottest Day.
		1857.	1858.	1859.	1860.	1861.	1862.	1863.		Lowest.	Year.	Highest.	Year.	
	°	°	°	°	°	°	°	°	°	°		°		°
1	60·0	59·0	56·9	59·6	55·7	61·8	57·9	60·2	59·82	52·0	1816	73·3	1836	21·3
2	60·6	57·0	54·8	62·2	61·9	62·5	56·9	61·4	60·45	51·0	1821	75·0	1836	24·0
3	61·3	59·8	55·0	66·0	61·7	60·7	51·4	62·2	61·05	51·0	1821	72·1	1828	21·1
4	62·3	60·8	58·4	64·9	61·7	57·3	56·2	60·4	61·97	53·6	1823	74·7	1836	21·1
5	63·2	61·6	56·1	65·1	56·3	58·6	61·5	62·8	62·79	51·7	1820	76·7	1836	25·0
6	62·7	59·0	56·5	69·3	57·2	59·7	60·6	64·1	62·45	54·7	1820	74·0	1848	19·3
7	61·6	54·7	54·2	70·0	55·1	62·8	58·0	68·3	61·44	52·0	1821	73·1	1826	21·1
8	60·9	55·1	55·4	68·5	54·8	61·3	61·6	62·3	60·75	48·0	1856	72·6	1826	24·6
9	61·0	59·6	54·4	68·1	56·8	62·1	58·9	65·7	60·97	53·0	1856	71·3	1826	18·3
10	61·8	62·0	56·2	68·6	53·9	60·7	56·6	66·4	61·64	53·9	1860	71·8	1836	17·9
11	62·0	65·4	64·7	72·3	59·5	59·3	53·3	65·3	62·12	51·7	1841	72·3	1836 and 1859	20·6
12	62·2	68·2	65·2	75·7	57·9	60·9	58·4	66·9	62·56	52·0	1854	75·7	1859	23·7
13	62·1	69·4	64·1	75·2	58·2	63·3	60·4	62·6	62·31	51·2	1833	75·2	1859	24·0
14	62·3	69·5	66·7	66·0	60·4	61·7	63·2	62·3	62·57	54·5	1841	73·3	1824	18·8
15	62·4	72·7	73·5	68·4	62·7	61·1	68·3	66·8	62·93	54·2	1841	79·1	1825	24·9
16	61·7	66·6	64·5	70·7	58·4	62·1	57·2	58·8	61·83	50·7	1834	74·1	1825	23·4
17	62·6	63·0	66·1	73·2	62·3	60·6	57·0	56·5	62·61	53·6	1823	76·7	1834	23·1
18	62·0	66·4	62·8	74·3	58·1	61·0	61·6	53·1	62·07	52·3	1816	78·2	1825	25·9
19	61·2	69·0	62·8	70·9	57·4	59·6	58·5	57·0	61·34	53·9	1834	78·6	1825	24·7
20	61·4	69·3	64·6	67·7	58·9	63·0	59·8	57·1	61·61	47·7	1836	70·8	1825	23·1
21	61·2	64·5	60·7	66·5	55·6	61·9	61·1	55·6	61·15	53·3	1819	69·4	1835	16·1
22	61·5	66·3	60·6	68·9	58·5	61·8	57·1	58·0	61·51	53·2	1832	68·9	1859	15·7
23	61·4	71·4	65·7	61·5	53·8	62·4	55·7	58·9	61·39	53·8	1826 and 1860	72·7	1818	18·9
24	62·0	70·8	62·9	59·9	54·4	58·2	58·7	56·1	61·72	54·0	1838	79·2	1818	25·2
25	61·9	67·0	60·7	62·1	53·6	63·7	64·5	58·1	61·83	53·6	1860	73·0	1854	19·4
26	61·5	61·5	60·5	69·2	54·8	59·9	64·1	54·5	61·38	53·1	1829	73·1	1830	20·0
27	62·1	65·6	61·3	71·5	57·5	59·6	61·8	60·0	62·14	51·6	1823	74·0	1837	22·4
28	62·8	63·7	58·4	71·4	56·4	59·4	58·9	62·6	62·63	54·7	1817	74·6	1814	19·9
29	62·6	64·6	50·3	69·3	57·5	59·7	61·1	63·7	62·48	52·0	1816	73·9	1827	21·9
30	62·4	65·9	60·0	65·4	56·9	61·2	60·0	61·3	62·28	53·2	1841	76·3	1830	23·1
31	62·3	70·8	60·1	67·5	57·3	60·8	60·6	56·7	62·25	53·6	1841	74·8	1826	21·2
Means	61·8	64·5	60·7	68·6	57·6	60·9	59·1	60·8	61·81					

The mean temperature of the coldest day in July, in fifty years, was 47°·7, on the 20th day in the year 1836.

The mean temperature of the hottest day in July, in fifty years, was 79°·2, on the 24th day in the year 1818.

The difference between these numbers is 31°·5, and it represents the extreme difference between the mean temperature of two days in the month of July in fifty years.

The day of the month whose mean temperature has been subjected to the greatest difference, 25°·9, was the 18th; and that to the least, 15°·7, was the 22nd.

TABLE VIII.—AUGUST.

Mean Temperature of every day in the month of August, as deduced from the observations taken on that day, at the Royal Observatory, Greenwich, in the fifty years ending 1863; and Extremes of Mean Temperature for every day within the same period.

Days of the Month.	Mean of Temp. of 43 Years.	Mean Daily Temperature of the Air.							Mean of Temp. of 50 Years.	Lowest and Highest Mean Daily Temperature in 50 Years.				Diff. between the Coldest and Hottest Day.
		1857.	1858.	1859.	1860.	1861.	1862.	1863.		Lowest.	Year.	Highest.	Year.	
	°	°	°	°	°	°	°	°	°	°		°		°
1	62·3	66·9	60·8	65·7	59·8	63·6	64·8	60·4	62·30	54·0	1841	75·3	1825	21·3
2	62·5	68·2	59·7	62·2	57·3	63·5	61·8	64·8	62·50	54·2	1822	74·2	1856	20·0
3	62·3	72·6	64·7	65·4	59·1	58·7	61·0	64·1	62·49	55·5	1854	72·6	1857	17·1
4	62·5	72·8	62·7	65·1	59·9	63·3	61·3	64·2	62·74	51·3	1854	72·8	1857	21·5
5	61·8	64·1	66·7	60·7	57·1	66·1	63·1	62·6	61·96	53·4	1854	74·2	1818	20·8
6	61·6	62·7	61·1	59·7	55·4	63·0	59·0	62·4	61·44	54·0	1823	74·5	1818	20·5
7	61·8	58·7	60·8	58·1	55·7	62·8	58·9	68·6	61·82	55·3	1823	69·4	1840	14·1
8	62·1	57·0	60·4	58·2	53·9	63·0	56·1	68·4	61·95	53·9	1860	70·8	1849	16·9
9	61·9	60·8	63·7	57·9	56·4	64·7	58·7	67·6	61·81	56·4	1848 and 1860	68·9	1842	12·5
10	62·2	63·5	65·8	57·5	57·5	68·2	56·6	68·8	62·20	55·1	1845	73·2	1842	18·1
11	62·5	66·7	67·6	62·3	58·3	67·7	59·2	66·3	62·71	55·9	1844	74·9	1835	19·0
12	61·8	67·4	71·8	66·1	57·9	72·9	59·8	61·9	62·30	54·3	1852	72·9	1861	18·6
13	61·9	68·6	66·5	67·1	58·3	67·0	60·6	63·4	62·34	53·8	1830	70·0	1834	16·2
14	61·1	60·2	62·1	63·9	59·2	64·2	58·7	63·2	61·18	53·0	1828	68·7	1837	15·7
15	60·9	58·6	62·4	59·4	59·3	65·0	58·9	66·4	60·97	52·5	1829	69·8	1842	17·3
16	61·1	68·0	63·5	59·5	61·1	59·4	57·4	66·2	61·25	52·5	1845	69·1	1842	16·6
17	61·0	61·7	67·5	60·7	56·2	60·4	56·9	59·6	60·92	53·5	1830	74·4	1837	20·9
18	61·0	63·1	67·0	66·6	52·9	63·8	56·1	56·5	60·98	52·5	1830	74·3	1842	21·8
19	61·0	64·5	67·3	68·1	58·7	63·5	61·5	53·6	61·20	50·7	1839	71·7	1837	21·0
20	60·5	64·6	60·7	69·4	59·0	59·4	60·7	55·3	60·81	47·0	1839	73·3	1826	26·3
21	60·9	64·8	54·8	62·6	53·9	58·3	63·3	55·8	60·64	49·4	1839	71·0	1835	21·6
22	60·0	69·2	60·8	63·4	56·1	59·9	60·1	59·5	60·18	50·2	1817	71·9	1822	21·7
23	60·5	72·4	62·4	66·3	55·6	64·1	58·8	63·7	60·90	53·0	1856	72·4	1857	19·4
24	60·1	73·6	63·0	69·1	55·4	59·3	57·1	59·5	60·42	53·6	1841	73·6	1857	20·0
25	60·3	70·1	58·6	73·4	59·8	59·0	58·4	59·1	60·62	52·3	1834	73·4	1859	21·1
26	60·2	66·1	56·9	65·9	59·0	60·7	61·7	57·1	60·32	51·2	1817	66·7	1849	15·5
27	60·3	64·8	57·6	65·4	56·3	65·4	61·2	60·3	60·48	53·9	1814	67·2	1831 and 1854	13·3
28	60·2	60·6	55·3	58·7	57·2	65·5	58·5	61·0	60·27	52·6	1814	70·7	1854	18·1
29	60·0	61·0	56·2	62·0	59·7	63·4	56·8	59·3	59·97	49·3	1832	71·0	1826	21·7
30	59·8	68·0	57·9	55·5	59·2	62·4	56·8	60·3	59·83	49·3	1837	70·6	1826	21·3
31	58·4	67·7	56·8	53·3	51·4	60·8	60·0	59·6	58·54	43·2	1833	69·0	1825	25·8
Means	61·1	65·4	62·0	63·5	57·7	63·2	59·5	61·9	61·23					

The mean temperature of the coldest day in August, in fifty years, was 43°·2, on the 31st day in the year 1833.

The mean temperature of the hottest day in August, in fifty years, was 75°·3, on the 1st day in the year 1825.

The difference between these numbers is 32°·1, and it represents the extreme difference between the mean temperature of two days in the month of August in fifty years.

The day of the month whose mean temperature has been subjected to the greatest difference, 26°·3, was the 20th; and that to the least, 12°·5, was the 9th.

Table IX.—September.

Mean Temperature of every day in the month of September, as deduced from the observations taken on that day, at the Royal Observatory, Greenwich, in the fifty years ending 1863; and Extremes of Mean Temperature for every day within the same period.

Days of the Month.	Mean of Temp. of 43 Years.	Mean Daily Temperature of the Air. 1857.	1858.	1859.	1860.	1861.	1862.	1863.	Mean of Temp. of 50 Years.	Lowest and Highest Mean Daily Temperature in 50 Years. Lowest.	Year.	Highest.	Year.	Diff. between the Coldest and Hottest Day.
	°	°	°	°	°	°	°	°	°	°		°		°
1	58·9	64·6	58·8	55·4	56·9	66·1	56·2	56·2	58·94	44·5	1816	71·7	1824	27·2
2	58·9	53·6	58·0	57·9	54·4	64·6	60·2	56·1	58·75	45·5	1816	73·5	1824	28·0
3	59·2	53·7	65·2	59·4	55·2	61·8	55·2	60·5	59·13	46·8	1816	70·5	1824	23·7
4	57·8	55·3	62·7	56·0	54·8	59·8	55·8	56·8	57·73	47·8	1816	68·2	1818	20·4
5	58·4	60·0	56·8	57·3	56·9	66·0	54·3	55·1	58·35	48·8	1841	68·1	1848	19·3
6	57·9	62·6	55·4	59·1	56·8	60·1	57·2	54·0	57·90	47·9	1841	68·4	1846	20·5
7	57·7	61·4	57·6	57·6	56·3	58·1	59·1	57·6	57·78	48·8	1815	65·8	1821	17·0
8	57·8	60·7	61·4	61·5	58·0	58·1	49·9	54·8	58·00	47·1	1838	67·5	1828	20·4
9	57·6	60·6	59·2	59·6	52·6	61·7	62·9	56·2	57·79	48·8	1831	65·4	1843	16·6
10	57·7	62·3	62·6	55·1	49·9	57·7	53·5	52·3	57·49	47·4	1836	65·2	1825	17·8
11	57·5	55·4	62·9	54·6	50·1	54·1	51·8	52·3	57·07	47·0	1836	66·7	1839	19·7
12	57·0	60·3	65·3	57·6	49·8	57·5	56·8	54·4	57·05	47·3	1848	68·7	1841	21·4
13	56·8	60·2	65·9	51·8	54·0	55·5	61·7	56·9	57·22	49·9	1848	66·1	1841	16·2
14	57·3	59·8	64·6	50·8	56·4	56·1	59·2	52·6	57·27	50·4	1840	69·5	1823	19·1
15	57·1	62·7	62·6	53·0	55·5	52·5	61·8	56·5	57·20	46·4	1840	67·2	1815	20·8
16	57·3	66·1	63·4	54·4	56·3	55·1	59·1	56·2	57·49	47·7	1840	66·1	1857	18·4
17	57·4	66·7	62·9	54·4	59·5	53·0	55·4	53·8	57·47	49·4	1840	66·7	1857	17·3
18	56·4	63·1	58·7	52·6	51·5	54·5	55·1	56·2	56·34	48·1	1840	66·0	1843	17·9
19	55·4	56·1	53·9	55·8	51·8	57·3	59·5	60·4	55·54	45·2	1820	65·9	1843	20·7
20	55·5	58·6	59·5	53·8	55·1	54·6	60·2	49·7	55·55	46·6	1840	65·7	1825	19·1
21	54·5	55·4	59·0	52·6	55·6	58·7	55·5	50·6	54·52	44·0	1836	63·2	1825	19·2
22	55·4	57·3	62·7	54·7	55·1	55·3	54·6	51·7	55·46	45·4	1840	62·7	1858	17·3
23	55·1	60·2	63·2	58·8	50·1	55·7	52·6	49·9	55·20	47·1	1845	63·2	1858	16·1
24	55·7	61·8	56·9	67·4	48·9	54·7	55·9	48·9	55·79	44·3	1845	67·4	1859	23·1
25	55·3	62·2	55·2	62·0	46·9	50·6	58·3	52·0	55·30	44·7	1840	65·2	1825	20·5
26	54·7	58·5	56·9	59·8	49·4	51·5	59·4	50·1	54·75	43·8	1824	63·7	1828	19·9
27	53·8	60·9	59·3	56·2	53·6	52·8	60·2	51·6	54·16	43·3	1824	62·2	1849	18·9
28	54·1	56·1	56·9	58·7	51·3	55·7	60·1	49·2	54·29	40·7	1824	61·7	1826	21·0
29	53·5	57·0	61·6	56·5	50·7	58·0	61·0	49·5	53·90	46·2	1823	62·0	1832	15·8
30	53·5	57·9	59·2	56·2	49·2	61·5	58·5	50·5	33·87	44·7	1829	62·5	1819	17·8
Means	56·5	59·7	60·3	56·7	53·4	57·1	57·7	53·7	56·60					

The mean temperature of the coldest day in September, in fifty years, was 40°·7, on the 28th day in the year 1824.

The mean temperature of the hottest day in September, in fifty years, was 73°·5, on the 2nd day in the year 1824.

The difference between these numbers is 32°·8, and it represents the extreme difference between the mean temperature of two days in the month of September in fifty years.

The day of the month whose mean temperature has been subjected to the greatest difference, 28°·0, was the 2nd; and that to the least, 15°·8, was the 29th.

TABLE X.—OCTOBER.

Mean Temperature of every day in the month of October, as deduced from the observations taken on that day, at the Royal Observatory, Greenwich, in the fifty years ending 1863; and Extremes of Mean Temperature for every day within the same period.

Days of the Month.	Mean of Temp. of 43 Years.	Mean Daily Temperature of the Air. 1857.	1858.	1859.	1860.	1861.	1862.	1863.	Mean of Temp. of 50 Years.	Lowest and Highest Mean Daily Temperature in 50 Years. Lowest.	Year.	Highest.	Year.	Diff. between the Coldest and Hottest Day.
	°	°	°	°	°	°	°	°	°	°		°		°
1	53·8	58·7	52·5	61·1	50·9	64·3	52·2	53·8	54·14	44·2	1823	64·3	1861	20·1
2	53·5	58·4	57·1	59·4	53·1	57·6	58·5	52·4	53·94	37·7	1817	61·7	1837	24·0
3	53·4	59·6	57·7	63·9	53·7	57·5	61·0	57·1	54·13	39·9	1817	63·9	1859	24·0
4	54·0	51·2	58·7	66·8	47·6	58·6	55·4	58·0	54·37	45·0	1836	66·8	1859	21·8
5	52·9	49·4	50·6	60·8	53·0	57·5	56·1	49·4	53·03	42·5	1842	64·5	1834	22·0
6	52·2	50·3	48·8	62·7	55·6	56·0	59·1	44·8	52·44	42·5	1826	63·2	1848	20·7
7	52·7	52·2	53·7	63·2	54·9	60·6	51·3	53·8	53·12	37·4	1829	63·7	1848	16·3
8	51·7	51·5	47·6	58·1	49·0	62·1	56·4	58·9	52·13	39·7	1829	62·1	1861	22·4
9	51·0	48·5	47·9	57·6	45·9	58·2	56·0	50·8	51·16	38·7	1829	53·7	1839	21·0
10	51·8	52·1	50·5	56·3	43·6	56·5	57·7	57·8	52·04	38·0	1814	62·5	1819	24·5
11	52·4	52·6	46·3	53·9	41·6	58·0	57·3	54·7	52·35	41·6	1860	62·2	1819	20·6
12	50·9	59·7	48·6	53·6	38·6	56·4	57·0	54·3	51·14	38·6	1860	60·9	1826	22·3
13	50·3	57·1	55·8	53·1	36·8	59·6	54·7	52·8	50·86	36·0	1838	59·6	1861	23·6
14	50·2	53·0	57·5	56·6	36·6	62·3	60·0	55·9	51·01	41·6	1843	62·3	1861	20·7
15	49·2	52·8	56·8	56·1	49·7	57·5	58·2	52·8	49·99	38·3	1843	59·2	1826	20·9
16	48·9	55·1	55·9	55·9	49·5	52·2	52·0	52·9	49·52	35·8	1843	60·2	1818	24·4
17	48·8	55·8	51·3	55·6	50·0	50·2	51·2	53·4	49·32	36·4	1824	56·9	1818	20·5
18	49·2	53·2	47·1	51·0	50·5	50·2	44·5	54·0	49·32	38·0	1848	59·7	1849	21·7
19	49·9	54·4	52·5	52·6	54·6	50·1	47·2	57·5	50·29	40·4	1842	59·5	1849	19·1
20	49·4	54·1	53·9	50·2	48·9	51·3	45·6	55·0	49·66	36·2	1842	59·1	1849	22·9
21	48·7	51·4	51·2	36·8	46·1	54·7	47·8	55·4	48·75	35·6	1842	60·7	1826	25·1
22	49·5	44·3	50·9	36·3	50·5	53·9	53·0	54·9	49·45	35·5	1819	60·7	1826	25·2
23	49·1	49·0	50·8	33·3	54·6	51·9	49·3	56·9	48·94	33·3	1859	58·7	1826	25·4
24	48·1	53·9	51·3	32·1	56·4	56·4	43·9	53·7	48·12	32·1	1859	57·4	1826	25·3
25	47·0	54·0	50·1	38·1	56·5	58·6	45·3	55·5	47·38	35·2	1819	58·6	1861	23·4
26	45·7	52·5	49·1	42·1	54·7	52·2	49·0	53·6	46·17	37·5	1819	54·7	1860	17·2
27	46·7	53·9	48·6	36·7	53·4	48·9	50·1	53·6	46·87	34·5	1819	57·5	1853	23·0
28	46·9	53·3	49·3	45·6	57·0	47·0	46·4	48·9	47·28	35·8	1819	59·9	1831	24·1
29	45·4	50·2	41·1	42·6	53·8	46·8	42·4	47·8	45·54	28·4	1836	55·5	1847	27·1
30	46·6	48·9	41·1	41·7	53·2	47·6	40·1	45·7	46·44	30·6	1836	56·7	1822	26·1
31	46·8	48·1	41·1	45·3	47·5	48·3	48·6	44·8	46·72	31·4	1836	57·0	1854	25·6
Means	49·9	52·9	50·8	50·9	50·6	54·9	51·8	51·6	50·18					

The mean temperature of the coldest day in October, in fifty years, was 28°·4, on the 29th day in the year 1836.

The mean temperature of the hottest day in October, in fifty years, was 66°·8, on the 4th day in the year 1859.

The difference between those numbers is 38°·4, and it represents the extreme difference between the mean temperature of two days in the month of October in fifty years.

The day of the month whose mean temperature has been subjected to the greatest difference, 27°·1, was the 29th; and that to the least, 16°·3, was the 7th.

Table XI.—November.

Mean Temperature of every day in the month of November, as deduced from the observations taken on that day, at the Royal Observatory, Greenwich, in the fifty years ending 1863; and Extremes of Mean Temperature for every day within the same period.

Days of the Month.	Mean of Temp. of 43 Years.	Mean Daily Temperature of the Air. 1857.	1858.	1859.	1860.	1861.	1862.	1863.	Mean of Temp. of 50 Years.	Lowest and Highest Mean Daily Temperature in 50 Years. Lowest.	Year.	Highest.	Year.	Diff. between the Coldest and Hottest Day.
	°	°	°	°	°	°	°	°	°	°		°		°
1	47·3	51·6	37·9	51·4	46·9	41·4	51·0	42·6	47·13	34·0	1829	57·7	1821	23·7
2	47·2	53·1	42·9	51·4	43·3	38·2	50·4	44·8	47·01	34·5	1823	59·7	1821	25·2
3	46·0	58·8	43·8	48·3	39·2	39·2	49·9	45·7	46·04	33·1	1820	58·8	1857	25·7
4	45·0	54·8	47·2	47·2	40·2	40·9	49·1	56·0	45·44	34·7	1815	56·0	1863	21·3
5	46·0	55·5	47·5	48·9	40·6	47·9	46·8	54·2	46·42	36·4	1820	57·7	1834	21·3
6	46·2	52·2	43·0	50·3	42·1	45·8	40·1	40·3	46·89	36·3	1842	57·5	1834	21·2
7	45·6	50·4	41·5	54·2	42·1	42·3	38·6	47·5	45·49	33·6	1837	56·9	1852	23·3
8	44·0	46·6	43·7	51·3	39·6	39·4	40·0	48·3	43·91	29·0	1816	58·3	1852	29·3
9	43·1	49·9	38·1	46·1	37·5	38·4	47·7	41·3	42·89	34·5	1843	55·9	1852	21·4
10	44·5	49·7	34·6	38·5	38·0	42·2	39·9	37·7	43·85	32·4	1816	55·0	1824	22·6
11	44·9	55·6	39·8	37·0	38·4	43·7	33·3	38·1	44·22	29·4	1828	54·7	1821	25·3
12	44·5	39·2	36·9	39·5	40·4	42·5	35·1	37·4	43·68	28·8	1828	53·4	1829	24·6
13	43·4	38·0	38·7	39·0	42·4	39·1	31·6	40·6	42·70	29·3	1825	53·3	1827	24·0
14	42·5	46·8	42·9	38·6	43·7	40·7	34·1	47·7	43·74	33·7	1820	55·0	1821	21·3
15	42·0	44·9	37·5	33·8	45·8	37·6	39·6	49·0	41·88	31·3	1851	58·0	1821	26·7
16	42·5	44·3	35·9	33·8	42·6	32·0	42·5	50·6	42·29	32·0	1861	56·9	1840	24·9
17	42·0	43·8	36·2	38·9	38·3	30·9	39·1	50·2	41·67	30·0	1815	55·4	1817	25·4
18	42·3	46·0	35·4	39·1	36·6	27·1	39·3	48·3	41·81	27·1	1861	51·3	1824	24·2
19	41·8	40·6	29·1	38·7	37·8	34·1	38·8	47·3	41·31	26·9	1815	51·8	1822 and 1845	24·9
20	42·4	43·7	31·7	40·2	41·1	41·8	36·6	45·7	41·98	26·1	1829	52·8	1822	26·7
21	42·6	46·0	34·1	35·3	41·7	47·3	36·7	49·3	42·53	29·1	1829	52·5	1831	23·4
22	42·1	45·9	32·9	39·6	43·5	42·9	35·3	46·7	41·96	28·3	1827	53·3	1831	25·0
23	40·5	48·7	26·4	40·4	37·6	38·1	29·5	48·3	40·24	24·6	1827	53·5	1831	28·9
24	41·3	49·0	26·5	41·8	39·9	30·6	33·9	52·1	40·87	23·4	1816	53·9	1846	30·5
25	40·3	38·3	42·5	44·7	38·5	43·2	36·6	52·8	40·49	30·0	1838	52·8	1863	22·8
26	40·9	37·6	51·9	39·7	37·3	53·1	38·8	49·0	41·46	27·7	1826	53·1	1861	25·4
27	40·0	42·0	47·6	46·6	42·3	42·1	39·6	45·6	40·44	28·5	1854	52·1	1843	23·6
28	42·0	39·1	47·8	43·0	40·4	41·1	42·9	41·0	41·97	26·1	1849	54·4	1828	28·3
29	42·4	41·4	49·0	40·4	41·7	51·9	38·3	36·8	42·44	29·0	1815	53·7	1818	24·7
30	42·6	39·7	43·8	39·7	45·3	49·7	37·7	35·4	42·39	28·5	1856	52·5	1823	24·0
Means	43·2	45·8	39·6	41·9	40·8	40·8	39·8	45·7	43·17					

The mean temperature of the coldest day in November, in fifty years, was 23°·4, on the 24th day in the year 1816.

The mean temperature of the hottest day in November, in fifty years, was 59°·7, on the 2nd day in the year 1821.

The difference between these numbers is 36°·3, and it represents the extreme difference between the mean temperature of two days in the month of November in fifty years.

The day of the month whose mean temperature has been subjected to the greatest difference, 30°·5, was the 24th; and to the least, 21°·2, was the 6th.

TABLE XII.—DECEMBER.

Mean Temperature of every day in the month of December, as deduced from the observations taken on that day, at the Royal Observatory, Greenwich, in the fifty years ending 1863; and Extremes of Mean Temperature for every day within the same period.

Days of the Month.	Mean of Temp. of 43 Years.	Mean Daily Temperature of the Air.							Mean of Temp. of 50 Years.	Lowest and Highest Mean Daily Temperature in 50 Years.				Diff. between the Coldest and Hottest Day.
		1857.	1858.	1859.	1860.	1861.	1862.	1863.		Lowest.	Year.	Highest.	Year.	
	°	°	°	°	°	°	°	°	°	°		°		°
1	42·5	47·3	44·3	36·4	45·4	43·4	41·4	43·7	42·56	28·9	1846	54·2	1832	25·3
2	41·9	50·8	46·2	33·4	45·0	36·5	40·7	45·4	41·98	27·7	1856	52·9	1838	25·2
3	40·8	52·4	43·7	32·1	43·6	37·5	44·3	42·6	41·04	31·3	1856	53·9	1847	22·6
4	41·7	46·7	49·4	36·7	44·6	37·0	45·9	41·4	41·89	30·1	1837	52·2	1833	22·1
5	42·6	44·3	43·0	47·9	44·6	39·4	50·2	49·3	43·06	29·8	1844	53·1	1852	23·3
6	41·5	49·4	33·5	44·2	49·8	41·8	53·5	42·4	41·95	26·4	1844	53·5	1862	27·1
7	41·5	50·9	34·6	42·3	49·9	48·3	51·7	47·7	42·20	28·2	1844	56·0	1856	27·8
8	41·1	41·7	36·7	42·0	44·8	47·6	42·2	48·1	41·40	26·9	1819	55·3	1856	28·4
9	40·4	43·7	38·2	39·1	42·7	48·7	44·3	47·7	40·84	26·2	1815	55·1	1856	28·9
10	40·1	46·8	35·3	37·0	41·4	49·1	46·5	42·9	40·47	25·9	1819	54·3	1848	28·4
11	39·3	42·2	34·5	30·8	39·6	45·6	43·5	48·0	39·48	20·9	1819	52·9	1852	32·0
12	40·1	40·6	36·2	33·5	40·8	50·3	38·3	50·4	40·28	27·8	1844	54·6	1814	26·8
13	40·0	41·4	41·9	33·5	40·4	50·6	42·1	42·0	40·25	25·5	1846	53·3	1848	27·8
14	40·8	40·8	38·2	27·9	38·8	44·7	39·0	42·9	40·54	24·5	1846	51·7	1854	27·2
15	40·7	46·9	38·1	27·0	36·2	46·1	38·7	44·4	40·57	23·5	1840	53·8	1849	30·3
16	40·4	48·5	36·9	25·1	38·4	47·8	41·7	44·0	40·41	25·1	1859	50·9	1833 and 1849	25·8
17	40·1	52·5	37·4	22·8	35·4	43·3	45·6	42·1	40·10	22·8	1859	52·5	1857	29·7
18	40·9	48·7	43·3	23·4	30·5	44·2	43·4	36·9	40·59	23·4	1859	53·9	1814	30·5
19	39·8	40·1	45·2	23·9	30·1	39·3	46·2	42·6	39·58	23·9	1859	52·6	1819	28·7
20	40·0	42·3	40·6	30·0	29·0	39·2	40·2	40·7	39·60	24·4	1855	52·6	1819	28·2
21	38·6	48·7	48·0	41·1	30·6	38·6	38·5	43·4	38·95	20·2	1855	53·1	1828	32·9
22	38·1	51·1	45·2	35·7	31·0	39·2	36·4	36·7	38·24	21·2	1816	51·6	1819	30·4
23	37·6	51·7	47·3	34·7	26·0	41·7	40·5	40·4	37·98	22·5	1840	51·7	1857	29·2
24	37·5	49·1	43·1	43·2	22·4	38·4	42·8	44·7	37·95	18·4	1830	50·5	1839	32·1
25	36·9	45·6	42·3	39·5	20·2	36·3	45·4	44·4	37·21	18·6	1830	53·1	1824	34·5
26	36·0	41·5	43·7	41·7	30·2	31·8	47·0	47·4	36·65	22·3	1835	48·4	1848	26·1
27	36·8	40·1	41·5	41·7	31·2	32·2	44·8	38·2	37·06	23·5	1829	50·1	1824	26·6
28	36·4	36·4	41·1	43·9	28·2	36·7	48·2	35·6	36·67	23·1	1822	48·2	1862	25·1
29	36·7	32·0	39·2	47·5	23·0	29·6	46·1	47·8	37·07	23·0	1860	49·9	1833	26·9
30	38·7	37·9	39·2	50·2	38·3	29·9	42·0	40·0	38·81	24·1	1822	51·7	1833	27·6
31	37·9	36·9	41·8	52·8	25·5	36·6	39·7	35·7	38·19	25·1	1819	52·8	1859	27·7
Means	39·6	45·1	41·0	36·8	36·3	41·0	43·6	43·2	39·79					

The mean temperature of the coldest day in December, in fifty years, was 18°·4, on the 24th day in the year 1830.

The mean temperature of the hottest day in December, in fifty years, was 56°·0, on the 7th day in the year 1856.

The difference between these numbers is 37°·6, and it represents the extreme difference between the mean temperature of two days in the month of December in fifty years.

The day of the month whose mean temperature has been subjected to the greatest difference, 34°·5, was the 25th; and that to the least, 22°·1, was the 4th.

Mean Temperature of every day in the year, as deduced from the observations taken at the Royal Observatory, Greenwich, in the fifty years ending 1863.

Days of the Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°	°	°	°	°	°	°
1	37·8	37·2	39·8	43·7	50·1	57·0	59·8	62·3	58·9	54·1	47·1	42·6
2	36·4	37·3	40·6	44·3	51·1	57·7	60·5	62·5	58·8	53·9	47·0	42·0
3	36·2	37·4	41·1	44·7	50·5	57·7	61·1	62·5	59·1	54·1	46·0	41·0
4	36·8	38·0	40·2	44·8	51·2	56·9	62·0	62·7	57·7	54·4	45·4	41·9
5	35·9	39·1	39·3	45·3	51·5	57·1	62·8	62·0	58·4	53·0	46·4	43·1
6	36·2	39·1	40·2	46·0	51·6	56·7	62·5	61·4	57·9	52·4	46·9	42·0
7	35·8	39·8	40·1	46·1	51·9	56·8	61·4	61·8	57·8	53·1	45·5	42·2
8	35·2	39·5	40·6	45·8	51·6	57·5	60·8	62·0	58·0	52·1	43·9	41·4
9	35·4	38·7	40·0	44·5	50·8	57·9	61·0	61·8	57·8	51·2	42·9	40·8
10	36·0	38·4	39·7	44·9	50·8	57·4	61·6	62·2	57·5	52·0	43·9	40·5
11	36·1	38·1	40·5	44·2	51·6	58·4	62·1	62·7	57·1	52·4	44·4	39·5
12	36·4	37·9	41·3	44·9	51·4	58·5	62·6	62·3	57·1	51·1	43·7	40·3
13	36·9	37·6	42·0	44·5	51·2	59·0	62·3	62·3	57·2	50·9	42·7	40·3
14	36·1	37·9	42·0	45·8	50·9	59·6	62·5	61·2	57·3	51·0	43·7	40·5
15	36·1	38·6	41·6	46·3	52·3	59·4	62·9	61·0	57·2	50·0	41·9	40·6
16	36·0	38·6	42·5	46·3	53·5	59·0	61·8	61·3	57·5	49·5	42·3	40·4
17	36·6	37·7	41·8	45·7	54·0	58·7	62·6	60·9	57·5	49·3	41·7	40·1
18	36·9	38·6	41·5	46·7	53·6	58·5	62·1	61·0	56·3	49·3	41·8	40·6
19	37·0	38·8	42·1	46·2	53·1	59·2	61·3	61·2	55·5	50·3	41·3	39·6
20	36·7	38·2	42·8	47·5	54·2	59·5	61·6	60·8	55·6	49·7	42·0	39·6
21	36·8	39·2	41·9	47·5	54·0	60·0	61·2	60·6	54·5	48·8	42·5	39·0
22	37·8	39·9	42·1	47·9	53·3	59·7	61·5	60·2	55·5	49·5	42·0	38·2
23	37·6	39·9	42·1	47·8	54·6	61·1	61·4	60·9	55·2	48·9	40·2	38·0
24	38·1	39·1	42·2	47·3	54·9	61·0	61·7	60·4	55·8	48·1	40·9	38·0
25	38·2	39·8	41·3	47·3	54·9	61·3	61·8	60·6	55·3	47·4	40·5	37·2
26	38·8	39·4	42·2	48·0	54·7	62·0	61·4	60·3	54·8	46·2	41·5	36·7
27	38·7	39·5	43·4	47·5	55·1	61·7	62·1	60·5	54·2	46·9	40·4	37·1
28	38·0	39·6	44·1	48·0	55·5	62·2	62·6	60·3	54·3	47·3	42·0	36·7
29	38·3	......	43·9	48·7	55·1	61·3	62·5	60·0	53·9	45·5	42·4	37·1
30	38·5	......	44·3	49·3	55·8	61·4	62·3	59·8	53·9	46·4	42·4	38·8
31	38·1	......	43·9	......	56·4	......	62·3	58·5	......	46·7	......	38·2
Means	36·9	38·7	41·7	46·2	52·9	59·1	61·8	61·2	56·6	50·2	43·2	39·8

The mean for the year $=49^{\circ}\cdot03$.

Notwithstanding that the above means have been deduced from fifty years' continuous observations, there are still many instances of the difference between the mean temperatures of two consecutive days exceeding half a degree. There are 9 such cases in January, 11 in February, 15 in March, 17 in April, 14 both in May and June, 12 in July, 4 in August, 9 in September, 19 in October, 20 in November, and 16 in December, or no less than 160 in the year. Of these exceeding 1° between the mean temperature of adjacent days, there were 3 in January, in February 2, in March 1, in April 3, in May 5, in June 3, in July 2, in August none, in September 3, in October 5, in November 7, and in December 4, or 38 in the year.

The largest of these differences in the several months were as follows:—In January, between the 21st and 22nd days, was 1°·04; in February, between 4th and 5th, was 1°·18; in March, between 26th and 27th, was 1°·18; there were two instances in April, both amounting to 1°·30, viz. between the 13th and 14th, and 19th and 20th; in May, the difference of 1°·34 appears between the 14th and 15th; there is one of 1°·54 between the last day in June and the first day in July; and a difference of 1°·10 appears between 15th and 16th of July; 0°·78 is the largest difference in August, between 4th and 5th; 1°·40 between 3rd and 4th of September; 1°·74 in October, between 28th and 29th; 1°·86 between 14th and 15th of November; and 1°·74 between the 29th and 30th of December.

The largest difference in the year between the mean temperature of consecutive days is 1°·86 between 14th and 15th of November. With differences so large as these, still remaining after fifty years' observations, it seems probable that 100 additional years of observations will be necessary to give results following each other progressively, and of their true values. It is therefore necessary to subject these numbers to some treatment so as to deduce from them the most probable mean temperature of every day. For this purpose all the values in this Table were laid down as ordinates, with the day of the year as abscissa, and a curved line was made to pass through or near all of them, giving equal weights to every point. From the line thus determined the ordinate of every day was measured, and the results are shown in the next Table.

TABLE showing the adopted Mean Temperature of every Day in the Year, as determined from all the thermometrical observations taken at the Royal Observatory, Greenwich, in the years from 1814 to 1863.

Days of the Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°	°	°	°	°	°	°
1	37·3	37·8	40·2	44·6	49·8	57·0	60·9	62·4	59·0	53·9	46·4	42·1
2	37·0	37·7	40·2	44·8	50·3	57·3	61·1	62·4	58·7	53·8	46·3	42·2
3	36·7	37·8	40·2	45·0	50·8	57·4	61·3	62·4	58·4	53·7	46·1	42·3
4	36·4	38·0	40·1	45·2	51·2	57·3	61·5	62·3	58·2	53·5	45·9	42·2
5	36·2	38·3	40·1	45·4	51·5	57·2	61·7	62·2	58·0	53·3	45·7	42·2
6	36·0	38·6	40·1	45·4	51·7	57·0	61·8	62·1	57·9	52·9	45·5	42·1
7	35·8	38·8	40·2	45·4	51·7	57·0	61·9	62·0	57·8	52·5	45·3	42·0
8	35·7	38·9	40·3	45·4	51·7	57·3	61·7	62·0	57·8	52·1	45·0	41·7
9	35·8	38·9	40·4	45·3	51·5	57·7	61·7	62·1	57·7	51·8	44·7	41·3
10	35·9	38·8	40·6	45·2	51·3	58·0	61·8	62·1	57·7	51·6	44·4	41·0
11	36·0	38·6	40·9	45·1	51·2	58·3	61·8	62·1	57·6	51·4	44·1	40·7
12	36·1	38·4	41·2	45·0	51·2	58·6	62·0	62·0	57·5	51·2	43·8	40·6
13	36·2	38·3	41·4	44·9	51·4	58·8	62·3	61·9	57·3	50·9	43·5	40·5
14	36·3	38·2	41·5	45·0	51·7	59·0	62·5	61·7	57·2	50·6	43·2	40·4
15	36·4	38·1	41·7	45·3	52·0	59·0	62·5	61·5	57·1	50·3	42·9	40·2
16	36·5	38·1	41·9	45·5	52·3	59·0	62·4	61·3	56·9	50·0	42·6	40·0
17	36·6	38·2	42·0	45·7	52·6	59·0	62·2	61·1	56·7	49·8	42·3	39·8
18	36·7	38·3	42·1	46·0	52·9	59·1	61·9	61·0	56·5	49·6	42·0	39·6
19	36·9	38·5	42·2	46·4	53·3	59·2	61·6	60·9	56·2	49·3	41·8	39·4
20	37·0	38·7	42·2	46·7	53·5	59·5	61·4	60·8	56·0	49·1	41·6	39·1
21	37·2	38·8	42·3	47·0	53·8	59·9	61·5	60·7	55·8	48·9	41·4	38·8
22	37·4	39·0	42·2	47·2	54·1	60·3	61·5	60·7	55·5	48·7	41·2	38·5
23	37·7	39·2	42·2	47·4	54·3	60·7	61·6	60·6	55·2	48·5	41·1	38·1
24	37·9	39·4	42·2	47·6	54·6	61·2	61·7	60·5	55·0	48·2	41·0	37·8
25	38·1	39·6	42·3	47·7	54·9	61·6	61·8	60·5	54·8	47·9	40·9	37·6
26	38·3	39·8	42·5	47·9	55·2	61·7	61·9	60·3	54·6	47·6	40·9	37·4
27	38·4	39·9	42·9	48·1	55·4	61·6	62·0	60·1	54·4	47·3	41·1	37·3
28	38·4	40·1	43·2	48·4	55·7	61·5	62·2	59·9	54·2	47·0	41·3	37·2
29	38·3	......	43·6	48·8	56·0	61·4	62·3	59·7	54·1	46·8	41·6	37·3
30	38·1	......	44·0	49·3	56·3	61·1	62·4	59·4	54·0	46·6	41·9	37·4
31	37·9	......	44·4	......	56·6	......	62·4	59·2	......	46·5	......	37·5
Means	36·9	38·7	41·7	46·2	52·9	59·1	61·8	61·2	56·6	50·2	43·2	39·8

The mean for the year $=49°{\cdot}03$.

The numbers in this Table are the best I can decide upon as the nearest approximation to the true temperature belonging to every day in the year. As compared with those determined from the forty-three years ending 1856, they are generally larger, particularly in January and December.

The day of the lowest temperature, 35°·7, is January 8; it then slowly increases to 37°·0 on the 20th, and then rather quickly to 38°·4 on the 27th; the temperature then declines to 37°·7 on February 2nd, increases to 38°·9 on the 8th and 9th, and declines to 38°·1 by the 15th and 16th; increases day by day to 40°·2 on March 1st and 2nd, and is nearly stationary for several days, differing only one-tenth of a degree from February 28th to March 7th; then increases to 42°·0 on March 17th; differs but little from 42° for a week, or till March 24th; increases then to 45°·4 by April 5, is stationary at this value till the 8th day, then declines to 44°·9 by the 13th day; a quick increase then sets in, and at the end of April the temperature increases 4°·4, being as much as the increase which took place between the beginning of March and the middle of April; the increase continues at the beginning of May, and is 51°·7 on the 6th, when it is checked, and remains stationary on the 7th and 8th; then declines half a degree by the 11th day, the temperature on the 11th and 12th of May being 51°·2; an increase then sets in, and on the 14th of May the temperature is the same as on the 7th and 8th, viz. 51°·7; a rapid increase now takes place, and on the last day of May the temperature is 56°·6. At the beginning of June the quick increase at the end of May is checked, and a slight decline takes place from 57°·4 on the 3rd to 57°·0 on the 6th and 7th, increases to 59°·0 by the 14th, is stationary till the 17th, then increases slowly to 61°·9 by the 7th day; the increase is checked till the 10th day and then increases to 62°·5 on the 14th and 15th of July, the absolute hottest days in the year; the temperature then declines to 61°·4 by the 20th; but this increases to 62°·4 for five days viz. from July 30 to August 3; and this is the hottest period in the year, the temperature continuing longer at these high values than about the 14th and 15th of July, which are distinguished as the hottest days in the year. From August 4th a decline sets in at first very slowly; several days together appear of nearly the same temperature; after the 28th day it sets in decidedly, and continuous, with very slight checks, to 40°·9 on the 25th and 26th of November; a very decided and remarkable increase then sets in to 42°·3 at the beginning of December, and till the 7th day

there appears but little change, and from the 8th day the temperature declines to 37°·2 by the 27th day, when again the decline is arrested; the temperature on December 31st rises to 37°·5, and finally declines to 35°·7 on the 8th day of January.

There are some variations of temperature particularly during the early months of the year and the months of spring, during which the increasing temperatures are checked for some days, which are remarkable. Among these I may mention the declining temperature at the end of January and beginning of February, between February 8th and 16th; the almost constant temperature at the beginning of March; and, again, from the 6th of April, followed by a fall; again in May, from the 6th day, and cold days from the 10th to 14th; the check at the beginning of June; then quick increase and stationary at 59° for some days, about the middle of March, are periods in the ascending branch of the curve of daily temperature for which it is difficult at present to assign any physical cause. In the declining branch, there is but one great break in its continuancy, and that is at the end of November; it is very remarkable indeed, and perhaps is the most so of any in the year: its probable cause may be owing to the south-west currents of air setting in over our country about this time.

FACTORS to be multiplied into the Mean Temperature of each month, as found from observations, extending from 1814 to 1863, to determine the Mean Temperature of every Day in the Month.

Days of the Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	1·009	0·978	0·965	0·965	0·941	0·964	0·985	1·019	1·042	1·074	1·072	1·058
2	1·002	0·975	0·965	0·969	0·950	0·969	0·988	1·019	1·037	1·072	1·070	1·060
3	0·993	0·978	0·965	0·974	0·960	0·971	0·991	1·019	1·032	1·070	1·066	1·063
4	0·986	0·983	0·963	0·978	0·967	0·969	0·994	1·017	1·028	1·066	1·062	1·060
5	0·981	0·991	0·963	0·982	0·973	0·967	0·997	1·015	1·025	1·062	1·057	1·060
6	0·976	0·998	0·963	0·982	0·977	0·964	0·999	1·014	1·023	1·054	1·052	1·058
7	0·969	1·003	0·965	0·982	0·977	0·964	1·001	1·012	1·022	1·046	1·049	1·055
8	0·967	1·006	0·968	0·982	0·977	0·969	0·997	1·014	1·022	1·038	1·042	1·046
9	0·969	1·006	0·970	0·980	0·973	0·976	0·997	1·014	1·020	1·032	1·034	1·037
10	0·972	1·003	0·975	0·978	0·969	0·981	0·999	1·014	1·020	1·028	1·027	1·025
11	0·976	0·998	0·982	0·976	0·967	0·986	0·999	1·014	1·019	1·024	1·021	1·021
12	0·977	0·993	0·989	0·973	0·967	0·991	1·003	1·012	1·017	1·020	1·014	1·019
13	0·980	0·991	0·994	0·971	0·971	0·995	1·007	1·009	1·013	1·014	1·007	1·016
14	0·983	0·989	0·996	0·973	0·977	0·998	1·011	1·007	1·011	1·008	1·001	1·014
15	0·985	0·986	0·968	0·980	0·983	0·998	1·011	1·004	1·009	1·002	1·994	1·009
16	0·988	0·986	1·005	0·984	0·988	0·998	1·009	1·001	1·006	0·996	0·987	1·004
17	0·991	0·989	1·007	0·989	0·994	0·998	1·005	0·997	1·003	0·994	0·980	0·999
18	0·993	0·991	1·011	0·995	1·000	1·000	1·001	0·995	1·000	0·990	0·973	0·994
19	0·999	0·996	1·010	1·004	1·006	1·002	0·996	0·993	0·994	0·982	0·968	0·988
20	1·002	1·000	1·010	1·012	1·011	1·006	0·992	0·992	0·990	0·978	0·965	0·982
21	1·008	1·000	1·015	1·018	1·017	1·013	0·994	0·991	0·987	0·976	0·959	0·974
22	1·013	1·010	1·010	1·022	1·022	1·020	0·994	0·991	0·982	0·970	0·955	0·966
23	1·021	1·015	1·010	1·028	1·026	1·027	0·996	0·989	0·976	0·966	0·953	0·958
24	1·026	1·020	1·000	1·032	1·031	1·035	0·997	0·987	0·972	0·960	0·950	0·949
25	1·031	1·025	1·015	1·034	1·037	1·042	0·999	0·987	0·960	0·954	0·946	0·944
26	1·036	1·030	1·020	1·038	1·043	1·044	1·001	0·984	0·965	0·948	0·946	0·938
27	1·039	1·033	1·030	1·042	1·047	1·042	1·003	0·980	0·962	0·942	0·951	0·936
28	1·039	1·038	1·038	1·048	1·052	1·040	1·005	0·976	0·958	0·936	0·958	0·934
29	1·036	……	1·048	1·058	1·058	1·038	1·007	0·973	0·956	0·932	0·965	0·936
30	1·031	……	1·058	1·068	1·063	1·033	1·009	0·969	0·954	0·928	0·971	0·938
31	1·026	……	1·065	……	1·069	……	1·009	0·966	……	0·926	……	0·941

The numbers in this Table show very clearly the distribution of the temperature of each month over itself.

That day in the month distinguished by 1·000 being of the same temperature as the month, all those less than unity being below, and those greater above, the average. Thus the two first days in January and from the 20th are above, and the remainder are below, the average. February is remarkable, and different from all the other months, being at first below, then above, again below, and finally above; the first part of all other months, to July, are below and the latter above; in the months from August, the first part of the months are above and the latter part below, and there are but two months in the year whose temperature of the middle day is that of the whole month; this is the case nearly in March and October, and the dividing-point in this respect is at different parts of the other months.

This Table may be used in deducing daily values from monthly means for other places, on the assumption that the law of daily decrease and increase of temperature at Greenwich will hold good for a considerable extent of country around. The daily temperatures will be found from the monthly by multiplying it by the factors for the different days.

Thus, if the mean temperature of January be 36°·94, the mean temperature of the first day will be 36°·94 × 1·009 or 37°·28; and that of the last day in the year, if the mean temperature for the month of December be 39°·82, will be 39°·82 × 0·941 = 37°·47.

TABLE showing the Distribution of Heat over the year, the Mean Temperature of the year being represented by unity.

Days of the Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	0·761	0·771	0·820	0·910	1·015	1·162	1·238	1·269	1·203	1·098	0·946	0·859
2	0·755	0·769	0·820	0·914	1·025	1·168	1·242	1·269	1·196	1·096	0·944	0·861
3	0·748	0·771	0·820	0·918	1·035	1·170	1·246	1·269	1·190	1·094	0·940	0·863
4	0·742	0·775	0·818	0·922	1·043	1·168	1·250	1·267	1·186	1·090	0·936	0·861
5	0·738	0·781	0·818	0·926	1·050	1·166	1·254	1·265	1·182	1·086	0·932	0·861
6	0·734	0·787	0·818	0·926	1·054	1·162	1·256	1·263	1·180	1·078	0·928	0·859
7	0·730	0·791	0·820	0·926	1·054	1·162	1·259	1·261	1·178	1·070	0·924	0·857
8	0·728	0·794	0·822	0·926	1·054	1·168	1·254	1·661	1·178	1·062	0·018	0·850
9	0·730	0·794	0·824	0·924	1·050	1·176	1·254	1·263	1·176	1·056	0·912	0·842
10	0·732	0·792	0·826	0·922	1·045	1·182	1·256	1·263	1·176	1·054	0·906	0·836
11	0·734	0·787	0·832	0·920	1·043	1·188	1·256	1·263	1·174	1·048	0·900	0·830
12	0·736	0·783	0·840	0·918	1·043	1·194	1·261	1·261	1·172	1·043	0·893	0·828
13	0·738	0·781	0·844	0·916	1·048	1·198	1·267	1·259	1·168	1·037	0·887	0·826
14	0·740	0·779	0·846	0·918	1·054	1·203	1·271	1·254	1·166	1·031	0·881	0·824
15	0·742	0·777	0·850	0·924	1·060	1·203	1·271	1·250	1·164	1·025	0·875	0·820
16	0·744	0·777	0·855	0·928	1·066	1·203	1·269	1·246	1·160	1·019	0·869	0·816
17	0·746	0·779	0·857	0·932	1·072	1·203	1·265	1·242	1·155	1·016	0·863	0·812
18	0·748	0·781	0·859	0·938	1·078	1·205	1·259	1·240	1·151	1·012	0·857	0·808
19	0·753	0·785	0·861	0·947	1·084	1·207	1·252	1·238	1·145	1·006	0·852	0·804
20	0·755	0·789	0·861	0·953	1·090	1·211	1·248	1·236	1·141	1·002	0·848	0·798
21	0·759	0·791	0·863	0·959	1·096	1·218	1·250	1·234	1·137	0·998	0·844	0·791
22	0·763	0·796	0·862	0·963	1·103	1·226	1·250	1·234	1·131	0·993	0·840	0·785
23	0·769	0·800	0·862	0·967	1·107	1·234	1·252	1·232	1·125	0·989	0·838	0·777
24	0·773	0·804	0·862	0·971	1·112	1·244	1·254	1·230	1·121	0·983	0·836	0·771
25	0·777	0·808	0·863	0·973	1·119	1·252	1·256	1·130	1·116	0·977	0·834	0·767
26	0·781	0·812	0·867	0·977	1·125	1·254	1·259	1·226	1·112	0·970	0·834	0·763
27	0·783	0·814	0·875	0·981	1·129	1·152	1·261	1·222	1·108	0·965	0·838	0·761
28	0·783	0·818	0·881	0·987	1·135	1·250	1·265	1·218	1·105	0·959	0·842	0·759
29	0·781	......	0·889	0·995	1·141	1·248	1·266	1·215	1·103	0·954	0·848	0·761
30	0·777	......	0·898	1·006	1·147	1·242	1·269	1·211	1·101	0·950	0·857	0·763
31	·0773	......	0·906	......	1·153	......	1·269	1·207	......	0·948	......	0·765

The distribution of the mean annual temperature is perhap more readily seen here than on the preceding Table.

The smallest number in the year is on January 8th; the day of mean temperature is April 29½; the largest number in this Table is 1°·271 on the 14th and 15th of July; the day whose mean temperature is again that of the year is October 20½.

Therefore the number of days, from the lowest temperature in the year to that of the mean, is 111½ days; between the latter and the hottest day is 76 days; but to the hottest period of the year, viz. the beginning of August, is 91 days; from the hottest day to that day whose mean temperature is that of the year is 99 days; from the hottest period of the year to the same day, viz. October 20½, is 84 days; and from the latter to the lowest in the year is 78½ days.

Assuming that on two days in the year the temperature is the same as the average of all, then 189 days are below the average and 176 above.

The number of days the temperature is rising from the coldest period in the year, viz. January 7th to 10th, to the hottest period in the year, viz. July 30th to August 3rd, is about 194 days; and the number of days from this period to the lowest again is about 171. The decline of temperature is therefore more rapid than the increase.

LXXXIII. *On the Secular Increase of Mean Temperature.* By J. Glaisher, Esq., F.R.S.

The mean temperature of the year, from the fifty years' observations ending 1863, was 49°·03; the mean temperature, as found from the forty-three years' observations ending 1856, was 48°·92. Thus the influence of the last seven years has been so great as to increase the average temperature of the year by no less than 0°·11. This is very remarkable.

By dividing the fifty years into two groups of twenty-five years each, we find then the mean temperature of the year as found

from the twenty-five years ending 1838 was 48°·61, and
from the twenty-five years ending 1863 was 49°·18,

showing the large increase of 0°·57 on the mean temperature of the year.

I now became desirous of knowing whether this rate of increase had been in operation before this series of observations began; for this purpose I used the results of the observations contained in my paper on the "Monthly Mean Temperature of the Air from the year 1771" (*vide* Phil. Trans. part 2, 1850).

I would have divided this series into groups of twenty-five years, as above; but I am short of 100 years of continuous monthly

results by seven, and therefore could not do so with groups of equal lengths and therefore of equal weights. I therefore took the ninety years ending 1859, and divided it into three groups, and the following are the results:—

That the mean temperature of the year from the

29	years' observations	ending	1799	was	47°·73
30	"	"	1829	"	48°·47
30	"	"	1859	"	49°·03

The increase of mean temperature here shown, from these ancient observations, agrees very closely with that found from modern observations, and is this, that the secular increase in the mean temperature of the year is 2°, or an average increase per year of 0°·02.

The result is so very important that it is necessary to look into every probable source of error, and to confirm it, or not, by every means possible.

If this be not a physical fact, then the most probable source of error would be the use of erroneous instruments. Now it is well known that the best thermometers made previous to the year 1840* were in error. The point 32° was determined by the use of melting but *un*drained ice, and the error from this cause was from 0°·2 to 0°·3, the instrument reading too high by this amount. At 100° the error was something less than 3°, reading likewise too high; and there was very little variation from these values in all the best instruments I have seen and examined, made at the end of the last century and beginning of this; and those were the errors existing at the time when my attention was first directed to the errors of thermometers, about the year 1840. The effect of this error on the ancient observations would be to cause the winter months to appear too high by ¼°, and the summer months too high by nearly 1°, or the whole year to appear too warm by more than ½°; and the effect would be to increase the difference between the earlier and later years by this amount. We therefore cannot attribute the apparent increase in the annual mean temperature to this cause.

The questions which now became important were to ascertain whether this increase was shown in every month of the year, or in some months or seasons more than in others, and, if so, the amount due to each month or season.

For this purpose the following Table has been used, showing the monthly and yearly mean of every month in groups of ten years.

TABLE showing the Mean Temperature of the Air at the Royal Observatory, Greenwich, in every Month, in successive groups of ten years.

Period.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	Means.
From 1771 to 1779 ...	° 33·5	° 37·7	° 41·6	° 45·6	° 52·0	° 58·4	° 62·0	° 61·2	° 55·6	° 49·5	° 41·8	° 39·4	° 48·2	
From 1780 to 1789 ...	34·9	36·6	38·8	44·9	52·8	58·4	61·5	60·0	55·7	47·3	40·5	36·1	47·2	47·73
From 1790 to 1799 ...	35·8	38·5	40·4	45·9	50·9	56·3	60·9	60·1	55·8	48·9	41·8	37·5	47·8	
From 1800 to 1809 ...	37·0	38·5	40·6	45·1	53·7	57·6	61·3	62·1	56·6	49·6	41·8	39·1	48·5	
From 1810 to 1819 ...	35·2	39·2	41·3	45·6	51·6	56·8	59·9	59·4	57·8	49·9	42·4	37·8	48·1	48·47
From 1820 to 1829 ...	35·4	38·1	41·8	46·8	52·6	58·2	61·8	60·2	56·7	49·9	43·3	40·8	48·8	
From 1830 to 1839 ...	36·0	38·5	41·3	44·5	52·9	58·8	62·3	60·3	55·4	50·1	43·1	39·9	48·6	
From 1840 to 1849 ...	37·6	38·4	41·9	46·9	54·3	59·6	61·2	61·2	56·8	49·5	44·0	39·7	49·2	49·03
From 1850 to 1859 ...	38·9	38·7	41·2	46·4	51·4	59·3	62·6	62·3	57·3	50·5	42·5	40·3	49·3	
Means	36·0	38·2	41·0	45·7	52·5	58·2	61·5	60·8	56·4	49·5	42·4	39·0	48·4	48·41

At once it is seen, by looking at this Table, that the months of November to February have been increasing in mean temperature, particularly the month of January; but that the summer months seem not to have varied much. By looking at the last column but one in the Table, and comparing the results at the beginning of the series with those of the end, it will be seen that the latter years have been warmer than the earlier; but, comparing the results of ten years' groups, there is no regular progress, and, therefore, the period of ten years is not of sufficient length to show the increase; a regular increase is shown by taking the means of thirty years, in the last column.

Grouping, therefore, the monthly values into thirty-year groups, we have the following Table:—

TABLE showing the Mean Temperature in every month in thirty-year groups.

Period.	January.	February.	March.	April.	May.	June.
	°	°	°	°	°	°
From 1771 to 1799......	34·7	37·6	40·3	45·5	51·9	57·7
" 1800 to 1829......	35·9	38·6	41·2	45·8	52·6	57·5
" 1839 to 1859......	37·5	38·5	41·5	45·9	52·9	59·2

Period.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°
From 1771 to 1799	61·5	60·4	55·7	48·6	41·4	37·7
" 1800 to 1829	61·0	60·5	57·0	49·5	42·5	39·2
" 1839 to 1859	62·0	61·3	56·5	50·0	43·2	40·0

These results are very remarkable. Large and continuous increases of temperatures are shown in the months of November, December, and January.

By taking the difference between the means as found from the whole series and those in each line of the above Table, the next Table is formed.

TABLE showing the excess of Monthly Mean Temperature, in groups of thirty years, above the Mean Temperature of the Month from all the years.

Period.	January.	February.	March.	April.	May.	June.
	°	°	°	°	°	°
From 1771 to 1799......	−1·3	−0·6	−0·7	−0·2	−0·6	−0·5
„ 1800 to 1829......	−0·1	+0·4	+0·2	+0·1	+0·1	−0·7
„ 1830 to 1859......	+1·6	+0·3	+0·3	+0·2	+0·4	+1·0

Period.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°
From 1771 to 1799	0·0	−0·4	−0·7	−0·1	−1·0	−1·3
„ 1800 to 1829	−0·3	−0·3	+0·6	0·0	+0·1	+0·2
„ 1830 to 1859	+0·5	+0·5	+0·1	+0·5	+0·8	+1·0

The sign − denotes that the temperature was below the average, and the sign + denotes that it was above the average.

The first thing here to be noticed is the fact of the numbers in the top line, excepting July, being all affected with the sign —, and those in the bottom line with the sign +, without exception, showing that every month in the year seems to have become warmer; the great difference in the amount of the numbers, in the different months, shows that they have not all increased in the same degree. The largest numbers are those in the months of November, December, and January with both signs, showing that the increases of temperature in these months have been the greatest. The numbers under the other months are comparatively small, April particularly, which is the most uniform of all the months, the next in order in this respect is October.

As the numbers in the different months differ so much, I think the differences between the results from the ancient and modern observations cannot be attributed to any kind of error in the instruments used, but tend to show that our climate is altering, and particularly in the months of winter.

By taking the monthly temperatures in groups of three months, the following Table is formed:—

TABLE showing the Temperature of the Air in periods of three Months.

Period.	January, February, March.	April, May, June.	July, August, September.	October, November, December.
	°	°	°	°
From 1771 to 1799	37·6	51·7	59·2	42·4
„ 1800 to 1829	38·5	52·0	59·6	43·8
„ 1830 to 1859	39·2	52·7	50·9	44·4

We see here a successive increase of mean temperature in every quarterly period.

Considering that the differences in the results thus found in the monthly, quarterly, and yearly mean temperatures between the early and recent observations are certainly not caused by instrumental errors, but are cosmical facts of the utmost importance, I next collected all those instances, in every month in the fifty years ending 1863, in which the mean temperature of the day had been several degrees below its average, and those days in which it had been several degrees above its average mean temperature in each month. For example, the mean temperature of January from all the years is about 37°. I selected all the days whose mean temperatures were below 25° and all those days whose mean temperatures exceeded 45°, and other days in every month whose mean temperatures were remarkably low or remarkably high, adopting limits in relation to the mean, as follows:—

Jan.	Mean	temperature	37°	adopted	limits, below	25°	and	above	45°
Feb.	„	„	39	„	„	30	„		45
Mar.	„	„	42	„	„	30	„		50
Apr.	„	„	46	„	„	35	„		55
May	„	„	53	„	„	40	„		60
June	„	„	59	„	„	50	„		65
July	„	„	62	„	„	55	„		70
Aug.	„	„	61	„	„	55	„		70
Sept.	„	„	57	„	„	50	„		65
Oct.	„	„	50	„	„	45	„		60
Nov.	„	„	43	„	„	35	„		50
Dec.	„	„	40	„	„	30	„		45

The following Table contains the total number of such days in every month in every year from 1814 to 1863.

Number of Days in every Month the

Years.	January. Below 25°.	January. Above 45°.	February. Below 30°.	February. Above 45°.	March. Below 30°.	March. Above 50°.	April. Below 35°.	April. Above 55°.	May. Below 40°.	May. Above 60°.	June. Below 50°.	June. Above 65°.
1814.	12	0	12	0	8	0	0	3	0	0	11	1
1815.	2	0	0	10	0	4	1	1	0	2	0	1
1816.	2	0	9	2	0	0	2	2	2	0	6	0
1817.	0	5	0	9	1	1	2	0	0	0	1	10
1818.	0	7	6	2	0	0	0	2	0	0	0	26
1819.	0	4	0	3	0	2	0	1	0	3	0	1
1820.	11	2	4	2	4	2	0	1	0	3	4	5
1821.	1	4	2	1	0	1	0	7	0	0	5	0
1822.	0	3	0	12	0	9	0	1	0	9	0	12
1823.	8	1	1	1	1	0	0	0	0	6	3	0
1824.	0	3	0	4	0	0	0	2	0	1	1	0
1825.	0	4	1	1	1	0	0	0	0	4	0	5
1826.	6	0	0	9	0	3	0	3	1	1	0	11
1827.	4	2	8	1	0	2	0	3	0	3	0	1
1828.	0	8	2	10	0	5	1	3	0	0	0	6
1829.	5	0	3	1	1	2	1	0	0	1	2	6
1830.	4	1	7	6	0	9	4	3	0	6	2	2
1831.	0	1	0	7	0	4	0	2	1	4	2	1
1832.	1	1	1	2	0	0	0	2	2	5	1	2
1833.	0	1	0	10	1	0	0	0	0	14	0	3
1834.	0	15	0	4	0	4	0	0	0	7	0	4
1835.	1	4	0	7	0	0	2	1	0	2	5	9
1836.	1	3	1	1	0	3	1	0	0	0	0	4
1837.	1	6	0	7	2	0	10	0	3	0	3	8
1838.	13	0	12	0	0	2	6	0	0	3	2	2
1839.	0	2	1	4	5	0	6	1	2	0	2	3
1840.	1	7	5	3	0	0	0	7	0	4	2	1
1841.	4	0	10	3	0	3	0	5	0	8	2	0
1842.	0	0	0	3	0	3	0	4	0	0	0	7
1843.	0	3	4	1	0	6	0	1	0	0	0	0
1844.	0	5	2	0	0	1	0	5	0	1	0	5
1845.	0	2	8	0	8	1	0	2	1	0	0	5
1846.	0	15	0	11	0	1	0	0	0	2	0	16
1847.	0	2	7	4	1	2	1	0	0	6	0	0
1848.	1	1	0	16	0	3	0	4	0	16	0	3
1849.	1	10	0	11	0	1	1	0	0	5	0	1
1850.	0	1	0	14	0	0	0	0	0	1	1	8
1851.	0	9	0	4	0	0	0	0	0	0	2	5
1852.	0	7	0	6	0	3	0	0	0	0	1	0
1853.	0	9	3	0	2	0	0	0	1	3	0	1
1854.	2	4	0	3	0	2	0	3	0	0	0	2
1855.	2	6	15	0	1	0	1	1	0	3	4	4
1856.	0	6	0	12	0	0	0	1	0	0	1	3
1857.	0	3	3	3	0	2	0	3	0	4	0	12
1858.	0	3	1	0	3	3	1	3	0	2	0	13
1859.	0	3	0	8	0	7	0	4	0	3	0	3
1860.	0	4	3	0	0	1	0	0	0	3	1	0
1861.	3	3	0	9	0	1	0	0	1	6	0	3
1862.	0	7	1	11	1	5	0	3	0	5	0	0
1863.	0	7	0	6	0	4	0	1	0	2	0	2

Mean Daily Temperature was—

July. Below 55°.	July. Above 70°.	August. Below 55°.	August. Above 70°.	September. Below 50°.	September. Above 65°.	October. Below 45°.	October. Above 60°.	November. Below 35°.	November. Above 50°.	December. Below 30°.	December. Above 45°.	Years.
0	1	3	0	0	0	7	0	3	0	0	11	1814.
3	0	0	0	4	3	2	0	15	4	5	5	1815.
6	0	9	0	6	0	5	0	11	0	3	2	1816.
3	0	9	0	3	0	23	0	0	14	7	2	1817.
0	6	0	2	1	2	2	1	0	14	6	7	1818.
1	2	1	0	2	2	14	5	7	0	11	6	1819.
4	1	5	0	8	0	9	0	4	2	6	11	1820.
7	0	0	0	0	4	4	1	0	11	0	10	1821.
0	0	1	2	1	0	3	2	0	9	7	0	1822.
5	0	2	0	4	2	7	0	3	4	0	8	1823.
0	1	0	0	4	4	7	0	1	9	0	12	1824.
1	9	0	1	0	5	6	5	3	1	1	9	1825.
1	10	0	6	0	0	4	4	5	0	0	9	1826.
0	1	2	1	1	0	3	0	3	4	0	13	1827.
2	2	1	0	1	2	3	0	3	6	0	18	1828.
1	0	5	0	6	0	10	0	8	1	10	1	1829.
0	6	7	0	2	0	6	1	4	6	5	0	1830.
0	0	0	1	1	0	0	2	4	7	1	9	1831.
2	1	3	0	1	0	1	1	0	3	0	6	1832.
5	0	4	0	2	0	4	0	2	4	0	14	1833.
2	1	3	0	0	2	3	3	0	6	0	8	1834.
1	3	1	3	0	2	9	0	1	5	9	2	1835.
4	6	2	0	8	0	6	0	3	3	5	8	1836.
0	1	3	2	0	1	3	3	5	2	0	11	1837.
3	0	2	0	10	1	5	0	4	1	0	4	1838.
2	0	6	0	2	1	5	0	2	5	0	7	1839.
2	0	2	1	11	2	13	0	3	3	10	1	1840.
7	0	3	0	2	3	4	0	6	3	3	9	1841.
0	0	1	2	2	1	13	0	0	0	0	16	1842.
1	1	0	1	4	7	12	1	2	5	0	14	1843.
1	1	3	0	2	0	3	0	1	6	9	0	1844.
1	1	4	0	3	0	4	1	1	7	0	8	1845.
0	4	0	2	1	4	4	0	2	8	11	1	1846.
0	4	0	1	5	0	1	0	2	9	0	13	1847.
1	1	2	0	2	1	4	4	0	4	2	15	1848.
0	2	0	1	0	5	5	0	4	7	1	7	1849.
0	3	5	0	0	0	13	0	1	12	0	8	1850.
2	0	4	0	2	0	3	2	8	0	0	9	1851.
0	5	1	1	1	0	6	0	0	13	0	24	1852.
0	0	0	0	2	0	2	0	3	4	7	0	1853.
3	1	3	1	0	1	6	1	4	1	0	7	1854.
1	0	0	0	0	0	2	0	1	1	7	4	1855.
2	1	1	4	2	0	4	0	4	2	5	9	1856.
1	4	0	5	0	2	1	0	0	7	0	16	1857.
3	1	1	1	0	3	3	0	7	1	0	6	1858.
0	9	1	1	0	1	9	6	2	4	6	4	1859.
6	0	1	0	6	0	3	0	0	0	6	3	1860.
0	0	0	1	0	2	0	4	5	1	2	9	1861.
2	0	0	0	0	0	3	1	5	2	0	11	1862.
2	0	1	0	5	0	4	0	0	6	0	9	1863.

Glancing the eyes down the several columns of this Table, it is at once seen that the preponderance of cold days in the winter months appears at the top of the Table. Of warm days in January there are but few at the top of the Table, and a good many at the bottom; in the other winter months this prevalence is less marked, and some of the months do not seem to be particularly marked by either peculiarity.

By taking the sums in 10-year groups the next Table is formed.

TABLE showing the Number of Days in each Month the Mean Temperature departed below or exceeded certain low and high Mean Temperature for every month.

Groups of Years.	Number of days in every month the mean daily temperature was																							
	Below 25°.	Above 45°.	Below 30°.	Above 45°.	Below 30°.	Above 50°.	Below 35°.	Above 55°.	Below 40°.	Above 60°.	Below 50°.	Above 65°.	Below 55°.	Above 70°.	Below 55°.	Above 70°.	Below 50°.	Above 65°.	Below 45°.	Above 60°.	Below 35°.	Above 50°.	Below 30°.	Above 45°.
	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.	
	days.	days.	days.	days.	days.	days.	days.	days.	days.	days.	days.	days.	days.	days.	days.	days.	days.	days.	days.	days.	days.	days.	days.	days.
1814 to 1823	36	26	34	42	14	19	5	18	2	23	30	56	29	10	30	4	29	13	76	9	43	58	45	62
1824 „ 1833	20	21	31	51	3	25	6	18	4	39	8	38	12	30	22	9	18	11	44	13	33	41	17	89
1834 „ 1843	21	40	33	31	7	21	25	19	5	24	16	38	22	12	23	9	39	20	73	7	26	33	27	80
1844 „ 1853	2	51	20	66	11	12	2	11	2	34	4	44	5	21	19	5	18	10	45	7	22	70	30	85
1854 „ 1863	7	46	23	43	5	25	2	19	1	28	6	41	20	16	8	13	13	9	35	12	28	25	26	78

There is evidently a very marked difference in the numbers here shown in some of the months, and which probably will be made sufficiently evident by dividing the whole series into two groups of 25 years each.

Thus divided:—

In the 25 years ending			days whose mean temperature was below		days above
in 1838, January, there were	72		25°, and	75	45°
„ 1863, „ „	14		25, „	109	45
„ 1838, February, „	78		30, „	112	45
„ 1863, „ „	63		30, „	123	45
„ 1838, March „	19		30, „	53	50
„ 1863, „ „	21		30, „	49	50
„ 1838, April, „	30		35, „	37	55
„ 1863, „ „	10		35, „	48	55
„ 1838, May, „	9		40, „	74	60
„ 1863, „ „	5		40, „	74	60
„ 1838, June, „	48		50, „	121	65
„ 1863, „ „	16		50, „	96	65
„ 1838, July, „	51		55, „	51	70
„ 1863, „ „	37		55, „	38	70
„ 1838, August, „	63		55, „	18	70
„ 1863, „ „	39		55, „	22	70
„ 1838, September, „	65		50, „	30	65
„ 1863, „ „	52		50, „	33	65
„ 1838, October, „	146		45, „	28	60
„ 1863, „ „	127		45, „	20	60
„ 1838, November, „	89		35, „	116	50
„ 1863, „ „	63		35, „	112	50
„ 1838, December, „	76		30, „	184	45
„ 1863, „ „	69		30, „	210	45

Thus we learn that in the 25 years ending 1838 there were:—

In January	58 more	extreme cold days than in the 25 years ending 1863.
„ February	15 „	
„ March	2 less	
„ April	20 more	
„ May	4 „	
„ June	32 „	
„ July	14 „	
„ August	24 „	
„ September	13 „	
„ October	19 „	
„ November	26 „	
„ December	7 „	

In every instance here, excepting in March, in which month there were a less number by 2, the number of extreme cold days in the

earlier period exceeds the number in the latter period of 25 years, in January by no less than 58, and in the year by 222. This difference is very great and very remarkable.

And that in the 25 years ending 1838 there were

In January	34 less	extreme warm days than in the 25 years ending 1863.
„ February	11 „	
„ March	4 more	
„ April	11 less	
„ May		the same number of extreme warm days as in the 25 years ending 1863.
„ June	25 more	extreme warm days than in the 25 years ending 1863.
„ July	14 „	
„ August	4 less	
„ September	3 „	
„ October	8 more	
„ November	5 „	
„ December	26 less	

There is not the same marked difference in the numbers of extreme warm days as in the preceding investigation of extreme cold days; the less and more affixed to the number belonging to each month are mixed together. January is the most marked, the number of its warm days in the latter period being 34 greater than in the former period. Taking the whole year, the result is an excess of 33 days more extreme warm days in the latter half of the series than the former.

Both these investigations confirm the previous result; both very forcibly point out the higher temperature at the latter period, and that it is chiefly owing to the far less number of severe cold days than of the greater number of extreme hot days; both operate the same way, by increasing the mean temperature of the year, and leave no doubt whatever that the increase is a real cosmical fact. During a great part of this series there has not been any doubt whatever on the correctness of the instruments used, and the known errors of those previously in use, if applied, would have made the differences still greater.

Turning now over to the observations at the end of the last century, I shall content myself with extracting from my paper on "Thermometrical Observations" (Phil. Trans. part 2, 1850) the description of the years beginning 1771 to the end of the last century.

Year 1771.—There were frequent and very sharp frosts till April 20th. On February 12th the reading of the thermometer was as low as 4°; the month of May was warm; the summer was cool and dry; October was a wet and windy month, and the weather was mild to the end of the year.

Year 1772.—The beginning of the year was mild; from the middle of January frosts and great snows were frequent, and continued to the middle of March. The summer was very fine; the autumn was mild but wet, and there was no frost till December 22nd.

Year 1773.—With the exception of the latter part of February, which was stormy and wet, there was much fine weather till the beginning of May; then many mornings were frosty, after which heavy rain fell frequently till June. The summer was fine; the autumn was wet. There were sharp frosts at the end of November and at the beginning of December.

Year 1774.—The year began with severe frost, and for nearly two months the ground was frost-bound; occasionally there were great rains or snow-storms; the weather was more moderate in April; the summer was cool, with heavy rains. The autumnal months were wet, particularly in September. Some snow fell in November and beginning of December. This year was remarkably wet.

Year 1775.—The weather was mild at the beginning of the year. The summer was dry and hot; thunder-storms were frequent in autumn. The year was very fine.

Year 1776.—In January there fell a greater quantity of snow than had fallen for some years, and the frost was supposed to have been the most severe since 1740. The frost went away at the beginning of February, and the weather following was mild and wet; it became hot about the middle of April. May was cold and dry, with north winds; after this the weather was mostly fine till the end of December, when there was a sharp frost.

Year 1777.—The year began with a sharp frost, and heavy falls of snow continued till towards the end of February; for a few days about the end of March the weather was unusually hot, the reading of the thermometer being nearly 70°; after this the weather was windy and cold till June. The latter part of the summer and autumn was fine. The year ended with frost and snow.

Year 1778.—There were frost and snow at the beginning of the year; the beginning of April was fine. The summer was fine and hot, supposed at the time to have been as fine a summer as that

of 1762, if not as fine as the summer of 1750. Frosty mornings began in September, but were less frequent afterwards. On the last day of this year there was a violent storm, supposed by some to have been as violent as that of 1703.

Year 1779.—After the beginning of January there was no frost; the spring months were remarkably warm. In February wall-fruit flowered; the middle of April was quite hot, as was the summer and autumn; about the middle of November there was a little frost, and again on December 22nd.

Year 1780.—This year began with a frost almost as severe as that in 1772; there was not much snow, and the weather continued severe till near the end of February. The month of March was warm; it was hot from July to September, and mostly mild till Christmas, when a frost set in.

Year 1781.—There was a little frost at the beginning of the year; the spring was mild, the summer was hot, and the ground was much burnt. Autumn was fine and pleasant, and there were only a few frosty mornings during the remainder of the year.

Year 1782.—The beginning of the year was mild, but in February it was frosty, and the remainder of the winter was severe; the spring was cold; nearly 12 inches of rain fell in April and May; the weather was fine in June, but bad afterwards; the autumn was cold; it was severe in November, and during the first half of December.

Year 1783.—The spring was pleasant, with frosty mornings very constant till near April. A remarkable haze was prevalent all over Europe during the summer. The autumn was fine, and the weather was mostly mild till the last week in December, when a great fall of snow took place.

Year 1784.—There was steady frost with snow till February 21st, and till the end of March the mornings were frosty; at the end of March there were cold winds with snow. This weather continued till the middle of April; and till the first week in May frosty mornings were frequent, and the remainder of May was exceedingly hot. There were a few hot days in July, but the weather was precarious throughout the autumn; and in December the frost was as severe as it was in January.

Year 1785.—The severe frost of the preceding month broke early in January, but on the last day of that month a second very severe frost set in and continued till the middle of March. This winter was most severe. The summer and autumn were showery; a heavy fall of snow took place at Christmas, with severe frost.

Year 1786.—The frosts at the beginning of the year were of short duration. From the beginning of March there was a severe frost of a fortnight's duration, and cold east and north-east winds were prevalent with frosty mornings till the beginning of May. June and July were moderately fine; August was cold and showery; and from this time to the end of the year there was a great deal of rain.

Year 1787.—The year began with open weather. April was cold with north winds, and vegetation was stopped; during April and May frosty mornings were frequent, and there was a sharp frost on the morning of the 7th of June; it was a cold summer; the autumn was mild, and there was a heavy fall of snow and a week's frost at the end of the year.

Year 1788.—January and February were mild, the latter month being wet; there was a fortnight's frost in March; there were several periods of hot weather in April, May, and June. The summer was in general dry; autumn was fine; there was a gentle frost at the beginning of December, then an exceedingly severe frost set in with heavy falls of snow, which continued to the end of the year.

Year 1789.—Very heavy storms of wind and snow took place till the middle of January; and large rivers were frozen over; there was a great loss of fish in ponds from the severity of the cold. After the frost broke the weather was mild, but windy and wet. During March there were nearly constant north winds, and heavy falls of snow were frequent with sharp frost. The summer was mostly wet; August was fine, after which it was again wet, and continued so to the end of the year, with scarcely any frost.

Year 1790.—The weather was mild and open till April, when the first snow fell in the year, and the weather, during the beginning of this month, was the most severe during the winter. The summer was cool, cloudy, and windy; autumn was fine and pleasant; December was stormy, with very changeable weather.

Year 1791.—Till January 6th there was frost; after this the weather was mild till towards the end of April; there were many frosty mornings with cold north-east winds in May. The former part of the summer was cold, frosty mornings were frequent till the middle of June. During November and December there were frequent storms and falls of snow and frost.

Year 1792.—There were frequent sharp frosts till March, with stormy and wet weather; the beginning of March was mild, after this there was a frost of a week's duration. The summer was wet

and cold; the autumn was wet, and December was cloudy, with very little frost. This year was very wet.

Year 1793.—January and February and beginning of March were mild; a frost set in at the end of March; there was a great fall of snow in the first week in April. The former part of the summer was cold, with frequently frosty mornings till June; July was wet; the autumn was fine, mild, and calm, and there was no frost till the end of the year.

Year 1794.—The year began with slight frost, which continued till the end of January; February was very mild; the spring was warm till May, which was cold; July was hot; the autumn was wet but mild, as was the first part of December, but the weather during the latter half of the month was severe with heavy snow.

Year 1795.—The frost began about the middle of December 1794, was excessively severe in January, and continued till the end of March. There were very large falls of snow, and the consequent floods were so great that nearly all the bridges in England were injured. Some snow fell in April. The summer was cold, with frequent frosty mornings till June; there were some hot days in July, but it was generally cold; after this the weather was fine till autumn. In December there was no frost.

Year 1796.—January was remarkably warm, with occasional thunder-storms; there was no frost till March, and then of no long duration. The summer was cool; the autumn was fine with a few frosty mornings at the end of November; in December a severe frost set in, and the reading of the thermometer in many places on the 24th was below zero of Fahrenheit's scale.

Year 1797.—During a few days in January the frost continued; after this, till the end of March, scarcely any rain fell, and the weather was fine with frequent frost. From April to September there were frequent heavy rains. The summer was cold; there was some warm weather in July; the autumn in general fine, and the weather continued open till the end of the year.

Year 1798.—With the exception of a few slight frosts, which occasionally occurred till March, the weather was open and mild. The summer was fine, as was autumn and the beginning of December; after this a very severe frost set in, and the reading of the thermometer was as low as 5°.

Year 1799.—The severe frost which set in about the middle of the preceding month continued to the middle of January, and again set in towards the end of the month with much snow, which continued during the first week in February; some snow fell in

March, and the mornings were frosty till the end of the month. From April to the middle of November was wet; December was foggy; and after the 17th a severe frost set in with snow falling. The whole year was remarkably cloudy.

This description of these several years would not at all apply to the description of the last thirty years. The character of the climate at the beginning of this series was certainly therefore very different from what it is now. Long continuance of frost and frequent and heavy falls of snow are facts which can be recorded without instruments as well as with them; in the early period they were of more frequent occurrence than in the middle period of thirty years, and far more so than in the latest period. Thus the results as found by this comparison without reference to instruments, and every investigation I have made, tend to confirm the accuracy of the indications found by instruments, viz.:—

(1.) That our climate in the last 100 years has altered.

(2.) That the temperature of the year is 2° warmer now than it was then.

(3.) That the month of January is 3° warmer.

(4.) That the winter months are all much warmer, and every month in the year seems to be somewhat warmer than before.

These results are indeed important, if true; and I cannot see how they can be otherwise than true. Their effects will be to influence agricultural produce; new fruits may be introduced with advantage, the character of our people will be altered. The result is of national importance. These results illustrate very forcibly, indeed, the advantage of long continuance of series of observations. Before such are begun the arrangements should be well considered, but once commenced, no change, if possible, should be made, and all alterations and circumstances should be carefully noted; for, if continued long enough, a reward will follow, which will repay every hour's attention which has been paid to the subject. Who, looking at the great, the frequent changes in our climate,—for instance, in January the mean temperature of a day as low as 10°·7 (1838, Jan. 20), another in January as high as 52°·7 (1834, Jan. 24), one whole month as low as 23°·9 (January 1795), another as high as 45°·3 (January 1796), one year of 45°·1 mean temperature (1784), another of 51°·3 (1846),—would have considered that even 100 years would have yielded the results here shown? This is the first time we have been able to speak with any confidence of this

increase of temperature, an increase spoken of and dwelt on for years past by very aged people.

I may, in conclusion, express a hope that series of observations now in progress over the world will be patiently continued; for other questions now open themselves—for instance, has any part of the world become 2° colder in its mean annual temperature in the last 100 years? or has the world itself increased generally 2° in warmth?—if the latter, some interesting astronomical facts would follow. Does the mean temperature oscillate in long periods? We have heard that fruits formerly ripened which do not now, as though there had been a warmer period than the present; and, if so, is there any connexion between the oscillation of mean temperature and of magnetism? These questions, with many others, press themselves on us, and make it extremely desirable that similar determinations to the above should be made as soon as possible at other parts of the world.

LXXXIV. *On a Method of obviating Parallax in reading off Thermometers.* By Lt.-Col. A. STRANGE, F.R.S., For. Sec.

THE art of observing has now arrived at such perfection that any improvement in it must relate either to convenience only or to the elimination of exceedingly small sources of error.

A small error in reading off a thermometer may be caused, as is well known to experienced observers, if the eye be not correctly placed. The line of vision should form a right angle with the stem of the thermometer at that point to which the column of mercury (or spirit as the case may be) has arrived. To take the case of a vertical thermometer, graduated on the stem as is now usual in good instruments, if the eye be placed higher than is required to fulfil the above condition, it is obvious that the extremity of the column will be referred to too high a point of the graduation, and the reading will be in excess; and, on the other hand, if the eye be too low, the reading will be in defect. In the case of a thermometer graduated on the plate to which it is fixed, the contrary effects will take place.

Hitherto the observer has had to depend solely on his own judgment in placing his eye, and it is probable that different observers will exhibit in this, as in every description of observation where an estimation has to be made, different personal equations.

The method I am about to describe affords a mechanical guide to the correct placing of the eye which must reduce such personal differences to the smallest possible limits, if indeed it do not annihilate them altogether.

It consists in graduating the stem of the thermometer on both sides, that is on the side next to the eye, as usual, and also on the side diametrically opposite to it. The two graduations may be considered as parts of parallel rings engraved round the stem. In viewing a thermometer so graduated, the divisions on the far side will be distinctly seen through the stem.

The observer must then raise or depress his eye until the two divisions (a far and a near one) nearest to the extremity of the column are seen to coincide, and thus take his reading. It is evident that there can be only one position of the eye in which this coincidence will take place, and that that position must be therefore constant for all observers using that particular instrument. And since the same mode of observing will be employed in comparing a thermometer so graduated with the standard to which it is to be referred, this contrivance seems calculated to ensure comparable results between distant observers, free from the error of parallax.

This method of graduating thermometers is due to my friend J. B. N. Hennessey, Esq., of the Great Trigonometrical Survey of India, and some very fine standard instruments executed on this plan by Mr. Casella have recently been supplied for the use of that department.

INSTRUMENTS.

1. *Self-registering Thermometer.* By G. Hamilton, Esq.

[Reprinted from the 'Monthly Notices' of the Royal Astronomical Society.]

I send a rough sketch of a self-registering thermometer which I have contrived, suited, I think, for observations, and capable of recording minute changes of temperature with any required degree of accuracy for every moment of time.

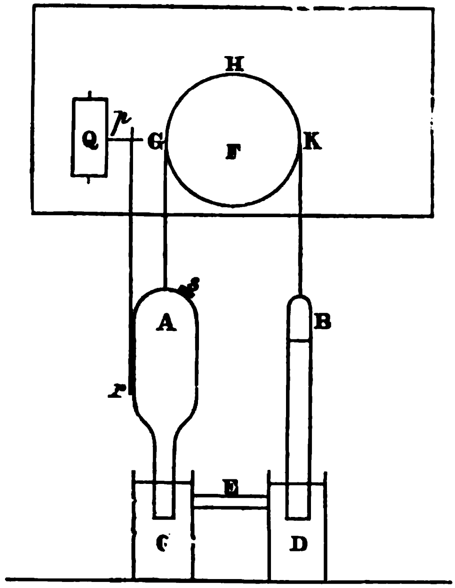
The upper part of the instrument—the wheel, clock-work, and revolving drum—could be enclosed in a case for protection against dust and rain; the air-vessel, A, might be fully exposed.

The principle of the instrument occurred to me whilst examining King's Self-registering Barometer, now in use at the Liverpool Observatory, and to Mr. King I am indebted for some of the de-

tails in the construction of the thermometer and for some valuable practical suggestions.

I left a sketch with Mr. Hartnup in the hope that the instrument might, if possible, be simplified or improved, and brought into use at Liverpool.

I shall be very happy to communicate with any other gentleman who might be similarly interested in the subject.



A, a vessel containing air, counterpoised by
B, a barometer-tube; both being suspended over
G, H, K, a wheel turning on the centre F.
C, D are vessels containing mercury, connected by the tube E, in order to keep the surfaces in both at the same level.
s, a screw, which may be opened to admit or expel air in adjusting the instrument.
Q, a drum made to revolve by clock-work, and covered with ruled paper, to receive the record.
p, a pencil, pressing against the paper by means of a weak spring, and connected by the rod, *p r*, to the air-vessel, A.

Let $E =$ Elasticity of air in A;
$H =$ Height of mercury in B;
and $P =$ Pressure of the atmosphere.

Then, because $E \propto P$
and $H \propto P,$
therefore $E \propto H,$

Hence the instrument will not be affected by changes of atmospheric pressure.

But any changes of temperature will change the volume of the air in A, and cause it to rise or fall; consequently, the pencil p will rise or fall, and trace a line on the revolving drum Q.

Queen's College, Liverpool, July 20, 1864.

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2. *On the Comparison between the English and Metrical Readings in Double-scale Barometers.* By WILLIAM MATHEWS, Jun.

[From the 'Philosophical Magazine' for December 1864.]

To the Editors of the 'Philosophical Magazine and Journal.'

GENTLEMEN,—In the July number of your Magazine is a paper by my friend Mr. Packe, in which he attributes the larger part of the discrepancy between the barometric pressures corresponding to the French and English boiling-points to the difference between the standard temperatures of the French and English units of length.

I believe this conclusion to be erroneous, and I propose to state, as briefly as possible, my reasons for dissenting from it.

"First," writes Mr. Packe, "as to the discrepance arising from the standard temperatures. That of the English barometer being 30° F. higher than that of the French scale, when the mercurial column is reduced to the freezing-point, the scale of the French barometer is also reduced to the freezing-point, but the scale of the English one is only reduced to the temperature of 62° F.

"*The consequence is that the French barometer, when reduced, will always read higher than the English barometer.*"

The unsoundness of this inference will appear from the following considerations:—

By reducing the French barometer we obtain the length of a column of mercury at 0° C., estimated in millimètres, at the standard temperature of 0° C.

By reducing the English barometer we obtain the length of the same column of mercury, at the same temperature, estimated in English inches, at the standard temperature of 62° F.

From Guyot's Tables for the conversion of millimètres into English inches, and *vice versa*, we express millimètres at the standard temperature of 0° C. in terms of English inches at the standard temperature of 62° F.

The consequence is that the reading of the French barometer, when reduced and converted into English inches by Guyot's Tables, ought always to coincide exactly with the reading of the English barometer.

From the following further quotation from Mr. Packe's paper, it is easy to see how he has arrived at a different conclusion:—

"For exact observation, therefore, it is useless to have a barometer marked with a double scale—the French and English; they cannot be made to coincide; *e.g.*,

"Let the barometer read 29 inches =736·59 millims. (temp. 62° F. =16°·67 C.). In the English scale at 62° (the temperature of the standard) no correction is made for the brass scale. The only correction is for the expansion of the mercury, —·087,

$$\begin{array}{rr} & \text{in.} \\ & 29 \\ - & \cdot 087 \\ \hline \text{reduced} & 28\cdot 913 = 734\cdot 38 \text{ millims.} \end{array}$$

"But in the French scale, the temperature of the standard being 32° F., the correction to be made is for the expansion of the mercury — the expansion of the scale:—

		millims.
Expansion of mercury for 16°·67 C.	=	2·212
Expansion of brass scale for ,,	=—	·231
		1·981

$$\begin{array}{rr} & \text{millims.} \\ & 736\cdot 59 \\ - & 1\cdot 981 \\ \hline \text{reduced} & 734\cdot 61 = 28\cdot 9224 \text{ inches."} \end{array}$$

Mr. Packe evidently supposes that in a barometer with a double scale, when the attached thermometer is at 62° F.=16°·67 C., and the English reading is 29 inches, the metrical reading will be 736·59 millims.

Now, if the metrical scale is properly graduated, this will not be the case. 736·59 millims. is what the reading would be if the metrical scale were at its standard temperature of 0° C. But by hypothesis it is at 62° F.; it has therefore expanded through the space due to an increase of temperature of 30° F., that is, through ·23 millim.

If, then, the English reading be 29 inches, the corresponding metrical reading will be 736·36 millims.

	millims.
	736·36
Reduction for 16°·67 C.	1·98
Reduced reading	734·38=28·913 inches;

precisely the same result that is obtained by the direct reduction of the English reading.

I make the proviso, *if the metrical scale is properly graduated*, as there is reason to fear that this is not the case with many double-scale barometers made in this country.

I am, Gentlemen,

Your obedient Servant,

WILLIAM MATHEWS, Jun.

51 Carpenter Road, Edgbaston,
November 7, 1864.

// PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

EDITED BY

JAMES GLAISHER, Esq., F.R.S., Secretary.

Vol. II. 1865, MARCH 15. [No. 18.

A. BRADY, Esq., Vice-President, in the Chair.

Jno. Browning, Esq., 179 Strand, W.C., and 111 Minories, E.C.;
W. C. Hughes, Esq., 78 Upper Stamford Street, Waterloo Road;
T. T. Pyle, Esq., M.D., The Esplanade, Bishop Wearmouth;
were balloted for and duly elected Members of the Society.

The name of One Candidate for admission into the Society was read.

LXXXV. *On the Pressure and Diffusion of Elastic Fluids.* By John Bloxam, Esq., M.B.M.S.

The discussion on Dalton's laws, commenced in the sixth Number of the 'Proceedings,' does not seem to be as yet exhausted. Professor Lamont still maintains that "Dalton's law itself needs a correction," that his conclusions "are perfectly untenable"*. It appears to me that Professor Lamont puts an erroneous interpretation on the law itself, that he consequently draws inferences from Dalton's law which the law does not warrant, and

* See Article LXXII. in No. 15 of 'Proceedings,' by Professor Lamont, as translated by W. T. Lynn, Esq.

endeavours to disprove that which was never asserted—that his experiments afford no evidence either for or against any part of Dalton's doctrine. No one at all acquainted with these matters can doubt that it is important to physical science that a correct understanding should be come to as to the soundness of Dalton's and of Lamont's doctrine. It has been said that Lamont "does not dispute that, where air and vapour are mixed, Dalton's law holds truly; but he asserts, and shows amply from experiments, that the dissemination does not at all take place according to the law of simple elastic gases;" and it is represented as being exclusively "against this idea of (vaporous) *dissemination* that Lamont's experiments are directed" *. Now in his paper, "Relation of Atmospheric Air to Aqueous Vapour," in the fifteenth Number of the 'Proceedings,' the Professor discusses the action of *the simple elastic gases*; and he says of the experiment he proposes, that the result would doubtless be "contrary to Dalton's supposition" †, that "there exists only one repulsive force amongst the permanent as well as non-permanent gases" †. It is therefore evident that Professor Lamont's objection to Dalton's law is far more comprehensive than it has been supposed to be; his objection (now at any rate) applies to all elastic fluids; he argues in favour of "a *mutual* repulsion" † as proper to all these fluids, in contradiction to Dalton's theory of *independent* pressure.

I think I may venture to assert that Professor Lamont's experiments totally fail in proving anything against Dalton's laws. What do the experiments prove? They prove that when several elastic fluids are set free in any space, the elastic force of one presses against any other that may be contained in the space, whilst they remain *unmixed*. This I take to be quite consistent with Dalton's law which asserts the principle of independent pressure; but Professor Lamont asserts the law of mutual repulsion as *antagonistic* to that of independent pressure. The law of mutual repulsion is unquestionably sound, under *the* experimental conditions; but Dalton's law does not deny the mutual repulsion under such conditions; to do so would be to deny the very principle of elastic force. I imagine that no one can doubt, or ever has doubted, that if any given space is divided into two parts or chambers open to each other, one part being occupied with one gas and the other part with any other gas, the two gases would reciprocally press upon each other; the pressure must be

* Proc. Meteor. Soc. vol. i. p. 366. † *Ibid.* vol. ii. p. 269.

just the same at the surface of elastic contact as at any other point of contact; this fact, though not "in conformity with Dalton's laws," is conformable to them. We are told by a high authority that "he (Lamont) does not dispute that, where air and vapour are mixed, Dalton's law holds truly." When they are not mixed, Dalton's law does not come into play at all. Lamont himself says, "I contrived an easily-performed experiment, in which, contradictory to Dalton's theory, a mass of vapour and a mass of air, placed in communication with each other, mutually preserve a state of equilibrium without the vapour penetrating into the air or the air into the vapour"*. In another place he says, "after the termination of the experiment, neither in the first nor in the second tube could a trace be perceived of the vapour having passed down into the bent part between *c* and *d*; so that it probably penetrated into the tubes either not at all or only to a small extent"†. Professor Lamont professes to experiment with the gases kept *unmixed*; but the Astronomer Royal uses an argument in support of Lamont's views which is not in accordance with this essential condition: he says, "but *aqueous vapour, combined with air, will not do so*; it will long remain in one place, as if the mixture of air and vapour produced viscosity. This is what Dr. Lamont shows"‡. Dr. Lamont professes to disprove Dalton's law of independence by an experiment in which the fluids experimented on are carefully kept separate; and this renders them incapable of refuting the law which applies to mixed fluids.

I do not pretend to show that Professor Lamont's arguments and theory are devoid of interest or value; but it appears to me that he is mistaken in supposing that they prove Dalton's laws to be erroneous. In his second paper he suggests a fresh experiment in support of his views; and though I doubt not the result of the experiment would be such as he anticipates, the argument founded on this result cannot, I think, be considered to shake Dalton's law itself. The assumption that Dr. Lamont's argument applies to the dissemination of aqueous vapour as distinguished from the simple elastic gases, is clearly negatived by the suggestion of this experiment, which deals with the permanent gases *only*. There can be no doubt that (1), with the stopcock in the apparatus described closed, the pressure must be precisely the same on each end of a drop of quicksilver, the pressure of the gas at one side must just balance the pressure of the atmosphere at the other.

* Proc. Meteor. Soc. vol. i. p. 313. † *Ibid.* p. 316.
‡ *Ibid.* p. 366.

(2) The pressure of the gas against the cock must be just the same as that it exerts against the drop of quicksilver; that is to say, the pressure here also is just that of the atmosphere. (3) Upon opening the cock between the two gases, the elastic forces of the gases will not be altered; that is to say, the pressure of each against the other will be the same as it had previously been against the cock: and this must be so as long as the two gases remain unmixed; to deny this mutual pressure or repulsion would be to assert that the gases lost their elastic force upon the turning of the cock. (4) When the two gases are perfectly mixed, each, being diffused through double the space, will lose half its elastic force, just as it would do if the other were not present; the oxygen will press with one half the force it did against its own drop, but the hydrogen will supplement this defect, and the resulting pressure at both extremities of the apparatus will be the same as at first; the drops will retain their original positions; each gas here tells upon both drops without control from the other gas. (5) If we contemplate the oxygen as pressing against and displacing the hydrogen and encroaching on the space *belonging* to the hydrogen upon the cock being turned, we may then regard the elastic force of the oxygen as diminishing; but this does not actually occur, because, whilst the oxygen encroaches on the space belonging to the hydrogen, the hydrogen encroaches on the space belonging to the oxygen: each gains what the other loses. This position may be viewed in another manner; so far as the oxygen in its endeavour to occupy the whole of the space open to it pushes against the hydrogen, instead of insinuating itself between the molecules of the hydrogen, to that extent it may seem to compress the hydrogen more, and to augment the elastic force of the hydrogen, and to increase the pressure of the hydrogen against its drop of quicksilver. But pressure in one direction and on one point is pressure in all directions and on all points; and consequently the pressure is as great against one drop as the other, and it is as great against the surface of contact of the oxygen as against that of the hydrogen; and thus both oxygen and hydrogen may as well be considered to gain force as to lose it, and to lose it as to gain it; that is to say, they do neither; the *expansion* of A tends to compress B, but the compression of B is *compression* to A, and the whole pressure against the boundaries of the space remains unaltered. The gases may exchange places (or may be supposed to do so), each giving and taking a half (say); but this being done without intermolecular dissemination,

each will continue to occupy the same extent of space, though not the same space; and this being so, each presses *directly* with its elastic force on half the area of each drop, instead of each pressing on the whole area of one drop directly and on the whole area of the other drop mediately. If the two gases are disseminated perfectly, each then presses with its whole force directly on the whole of both areas and on neither indirectly; but in this case the whole force is only the half of what it was when held in half the space: each compound half is equal to each simple whole. If one of the two gases assumed a different form according to its degree of pressure, it would indicate half the pressure when disseminated conjointly through the whole space that it did whilst occupying half the space exclusively: if this may be satisfactorily accounted for by the theory (and at present we have nothing but a theory to deal with) that the molecules of different gases individually collapse and so make room for one another, this goes to explain Dalton's law rather than to controvert it. Disintegration of the mass by the disseverance of its particles (by the increment of space between the particles) seems to imply diminished density rather than increased density. Such disintegration is compatible with the law of non-compression or non-condensation. Every gas *compresses* and condenses *itself*; but, according to Professor Lamont, it dissects and disintegrates *another* gas. Thus (granting the truth of Lamont's theory) the law of independent pressure holds good. If Lamont's view be correct (vapour-molecules being compressed, and separated further from one another, by the admixture of another gas, without liquefaction), it would seem that the additional pressure imposed by another gas would act as an obstacle to liquefaction, and that such additional pressure would raise the dew-point, whilst the fact is that the dew-point is not altered in any sense. The fact is not disputed that the additional elastic force that is obtained by adding any other gas to a body of vapour has no tendency when the two are mixed to condense the vapour in such a manner as to liquefy it; and consequently the word pressure seems at any rate to be used with two different significations, if it be applied both to the condensing pressure sustained from itself, and to the disintegrating pressure it endures from another gas*.

* The Professor contends for the theory that "there exists only one repulsive force amongst the permanent as well as non-permanent gases" (Proc. Meteor. Soc. vol. ii. p. 269). Is this compatible with the fact that, if vapour be in such a state of automatic pressure that the slightest addition of vapour will cause con-

It would appear that Professor Lamont misunderstands the real meaning of Dalton's law. In discussing the bearing of the proposed experiment, he says, "the oxygen of the space A will effuse itself, according to Dalton's theory, without exercising any pressure whatever upon the hydrogen...... ; and as this motion, on account of the friction, demands some time, the drop of quicksilver, *p*, must in the meantime advance further towards A"*. Now, in the first place, Dalton's theory does not assert that the oxygen would effuse itself, in the manner described, without exercising any pressure on the hydrogen; it only asserts that *when mixed* they would not press on one another. In the next place, supposing the oxygen to effuse itself into the space previously occupied by the hydrogen, it is quite clear that the hydrogen will simultaneously effuse itself into the space previously occupied by the oxygen, that the volume of each gas will not vary, that the elastic force of each will not be altered, that the drops of quicksilver will neither advance nor recede whilst the two gases are changing places, nor will they when the gases are mixed; neither will they whilst the gases are partially mixed, since they do not either in the mixed or unmixed state: and all this is perfectly in accordance with Dalton's laws and Dalton's theory. Under the assumption that the two gases are *not* independent (and no doubt they are not whilst they are two distinct bodies), one gas must lose in volume and increase in elastic force in the same proportion that the other increases in volume and loses in elastic force. If a body of hydrogen should intervene between one of the drops and the oxygen either mixed or pure, this intervening hydrogen will undoubtedly act as a cushion to receive pressure from the oxygen and transmit it to the drop.

Professor Lamont now insists upon it, that "the aqueous vapour existing in the atmospheric air does not, as it was generally supposed to do in conformity with Dalton's laws, form an atmosphere independent of the air, and subsisting by itself"†. The introduction of the words *as it was generally supposed to do*, may make this statement verbally correct; but the sentence, as it here stands, conveys a meaning which is objectionable; if the *general supposition* was erroneous, it does not follow that Dalton was in error. It has *not* been *proved* by an "experiment that Dalton's law itself needs a correction"†, though it doubtless has been proved that air

densation to ensue, it is nevertheless not subject to condensation at all by the superaddition of any amount of repulsive force from *another disseminated* gas?

* Proc. Meteor. Soc. vol. ii. p. 268, foot note. † *Ibid*, p. 266.

and vapour "mutually exercise a pressure upon each other"*. The experiment referred to† did not deal with vapour "in a space full of air"*; the space was *in part* filled with air and in part with vapour; and consequently the experiment cannot prove the dependence of the vapour on the air *when existing in a space full of air*; and then it follows that no need of correction has been shown to exist as regards Dalton's law itself.

It appears to me quite clear that Dalton's law itself does not need correction, and that his doctrine is not erroneous in the sense that Professor Lamont contends that it is. It is desirable to determine in what respect Dalton's teaching *is* defective. Dr. Lamont quotes Dalton's own expression of his views concerning the constitution of the atmosphere, as follows:—"His doctrine is, that, if several gases exist in the same space, each gas exerts a pressure upon its own molecules only, and each gas diffuses itself as if the other gases were not present at all"*. Now, although this be substantially correct, it is unquestionably not so literally: Dalton himself tells us that one elastic fluid diffuses itself very slowly in a space previously occupied by another, although it does so instantaneously when no other fluid is present; therefore each gas does *not* diffuse itself *as if no other were present.* No one, perhaps, will pretend to say, on this account, that Dalton's law itself needs a correction. "He adds moreover" (Lamont says) "that, if one or other atmosphere were suddenly withdrawn, this would have not the slightest effect upon the distribution and diffusion of the rest"*—"the rest would not at all be affected by the circumstance, either in their density or situation"‡. This, like the former statement, is certainly not literally correct. It is obvious (and I suppose every one at all acquainted with such matters must be aware of the fact) that the vapour in the atmosphere never can be equally distributed over the earth; and I do not understand that Professor Lamont supposes Dalton to have been ignorant of the many hindrances (which are well described in his last paper) to a normal relation being ever actually reached. The vapour never being in equilibrium, is habitually moving in favour of equilibrium; and it is quite clear that the vapour cannot thus move without dragging the other atmospheric constituents along with it; therefore if the vapour were withdrawn from the atmosphere, one peculiar and powerful agent in disturbing the uniform distribution of the rest would be removed; but this does not show

* Proc. Meteor. Soc. vol. ii. p. 266. † See Number 6 of 'Proceedings.'

‡ Proc. Meteor. Soc. vol. ii. p. 266, foot note.

that the law itself needs a correction. It is also a fact that Dalton's law does not serve for ascertaining the amount of vapour contained in a vertical column of atmosphere. The error has been committed (whether by Dalton or not is of secondary importance) of assuming that the vapour must be distributed in a column of atmosphere in strict accordance with Dalton's law of equal diffusion. The law (good as it is as a law) does not express the actual distribution of vapour in the atmosphere, either in a horizontal or a vertical direction.

Perhaps none of the laws of nature, *as we enact them*, are really sound laws; that is to say, they are all liable to be superseded by some other law, known or unknown to us. But independently of disturbing causes, the normal permanent condition of elastic fluids is that of independent and equal diffusion and independent pressure; whilst not in this state, they progressively approach to it; and having once attained it, they then remain in that state, in opposition to the law of gravity, unless some change take place in the external influences.

Professor Lamont has not proved the non-independence of the pressure of vapour when mixed with other elastic fluids. His theory on this point may be sound, and doubtless it is interesting, but it is not proved by any experiment to be sound: if it be sound, it does not appear to invalidate Dalton's law in this particular.

He has not proved the non-independence of the pressures of the permanent gases when mixed, though doubtless he has proved it in the unmixed state.

He has not established any ground for doubting the truth of Dalton's law of equal and mutual diffusion, though no doubt the working of this law is subject to very material hindrances in the atmosphere.

The application of Dalton's law of diffusion to the constitution of the atmosphere in different regions has always been known to be inadmissible.

The application of Dalton's law of diffusion to the constitution of the atmosphere at different heights in the same vertical column is clearly an error.

The application of Dalton's law of independent pressure to a column of atmosphere in which equability of diffusion does not exist is clearly an error.

LXXXVI. *On the General Weather of Europe during the Month of January* 1865. By A. J. CUMING, Esq., Librarian.

THE following description of the general European weather for January 1865, is compiled principally from the 'Paris International Bulletins,' but partly also from the "Daily Meteorological Report" published in 'The Times.'

The curves of the barometer and thermometer, and direction of the prevailing wind for each day of the month, exhibited at the last Meeting, were derived from the mean of observations at selected places, in England, France, Italy, and Russia, these countries being assumed to represent the four great divisions of the Continent. On examining these curves we find that on the 1st the barometrical readings over Europe were pretty uniform. On the 3rd, a fall of 0·39 in. was experienced in France, caused apparently by a strong N.W. wind, the effects of which were partly felt in England. From this day the pressure rapidly increased over the whole of Europe with the exception of Russia, where, on the 4th, it began to diminish, from the effects, apparently, of a severe storm from the west. The centre of this storm, which was only felt in Northern Europe, passed somewhat to the N. of Haparanda, the reading there on the 5th being 28·74 in., wind W., strong, changing to S. on the 6th, reading 28·80 in. At St. Petersburgh, on the 5th, the wind was S.W., strong, reading 29·41 in., and on the 6th S., light. From this time the pressure increased gradually in Russia, diminishing on the 11th, and again on the 15th, when the effects of the severe storm raging in England at that period were slightly felt*. It again increased, diminished gradually from the 19th to the 22nd, and then increased rapidly, attaining the maximum of the month on the 25th, the reading being 30·13 in. From this point the pressure diminished continuously, with only one exception, to the end of the month, being on the 31st 29·54 in.

In England and France the barometrical maximum was attained on the same day, the 7th; the centre of pressure was situated in the south-east of France, the maximum reading being 30·59 in. From this time, both in England and France, it diminished, at first gradually, till the 11th, when in England it decreased to 28·99 in. on the 12th, and to 28·46 in. on the 14th, this day being the crisis

* The Scandinavian Range breaking its force and arresting its further progress.

of the storm then raging. It increased rapidly on the 15th, decreased a little on the 16th, and then increased steadily till the 23rd, when it began to decrease, being on the 27th 29·29 in.; it increased again on the 29th to 29·92 in., and then decreased to 29·25 in., in consequence of a severe storm approaching the North of Europe.

In France on the 13th the pressure decreased rapidly, remained stationary on the 14th, and decreased on the 17th to 29·26 in. On this day the readings in England, France, and Italy were nearly identical, being in England 29·27 in., France 29·26 in., Italy 29·25 in. From this day (17th) the English and French pressures continue nearly uniform to the end of the month; on the 21st and 27th they are precisely the same, viz. 29·64 in. and 29·29 in.

The atmospheric pressure in Italy varied less, apparently, than in any other country. The maximum was attained on the 6th and 8th (30·27 in.), and the minimum on the 17th. On the 7th it decreased 0·35 in., apparently from a strong N.W. wind which blew over Marseilles. The pressure gradually decreased to the 17th, and as gradually increased to the 20th, and then remained nearly uniform to the end of the month, the extreme readings during eleven days showing a range of only 0·25 in.

Temperature.

From the 1st to the 8th, while the pressure was increasing in the West of Europe, the temperature ranged between 30° and 40°. From the 8th to the 16th, during the passage of the great storm, the temperature experienced a rise of about 10°. From the 16th to the 23rd it again fell, with checks on the 19th in England, and the 21st in France, until on the 23rd the temperature over Europe was nearly uniform. From this time a great divergence took place; N.E. winds blew over England and Russia, and lowered the temperature in both countries, in the latter to 4° on the 30th; while in France and South Europe S. and S.W. winds prevailed, causing an increase of temperature, rising to 48° on the 26th. Strong N. winds then came on, and the temperature fell in France to 30° on the 29th.

The changes in the Russian temperature were most marked. Commencing at 23° on the 1st, it fell to 6° on the 3rd, then rose to 33° on the 6th, which was also the day of minimum pressure. From the 13th to the 23rd it maintained a more uniform height; but on the latter day strong N.E. and E. winds began to sink it, to 7° on the 26th, and 4° on the 30th.

Wind.

In the earlier part of the month, to the 12th, the wind was generally light and variable over Europe, but strong in places. On the 11th, on the west coast of France and Spain it was light from S.E., and on the north from S.W., and generally along the coast. The first effect of the storm on the 12th was to increase the force of the wind without changing its direction; but on the 13th, on the west coast it changed to W., and greatly decreased in force, while on the north coast there was change in direction to N.W., but increased force. On the 14th the storm raged with great violence from the W. in France and up the English Channel. On the 15th it began to moderate in the west and north-west parts of Europe, and at the same time to affect the countries further inland: thus, on the 17th, at Marseilles it blew with great force from the W.

On the 27th a severe snow-storm occurred in England, the centre of which passed nearly over London, where on the 26th the wind was E., on the 27th N., and on the 28th N.W.; while at Brest on the 26th it was S.W., on the 27th N.N.W., and on the 28th N.W.

On the 30th and 31st a severe storm was approaching the North of Europe, the minimum pressure occurring on the 1st of February.

LXXXVII. *Notes on the Climate of Southland.* By Charles Rous Marten, Esq., of the Observatory, Martendale, Royal Bush, New Zealand.

No. I.

In commencing to transmit regularly my meteorological observations in this part of New Zealand, it appears desirable that I should make a few preliminary remarks on the climate whose phenomena I am about to record. Since the discovery of the Lake Wakatip Gold-fields, so much attention has been directed to the Province of Southland, that it is unnecessary for me to describe its geographical position, geological formation, or natural features, and I need merely observe that it is situated at the extreme south of the Middle Island of New Zealand, sheltered from S. to S.W. by the lofty mountains of Stewart's Island, W. round by N. to N.E. by the Aparima, Takihino, Eyre, and Hokanni Mountains, and exposed only to the direct E. and W.

winds which blow across the Great Southern Ocean. Although its highest S. latitude is about 46½°, the Province of Southland is almost *isothermal* with the county of Devonshire, the heat of summer and the cold of winter being alike tempered by the vast expanse of ocean which bounds it on three sides; and the observations of about six years lead me to consider the chief difference between the respective climates of the *county* and the *province* as lying in the greater dryness of the latter.

The first point of interest I have to notice in treating of the climate generally, is the remarkable example it affords of a rule I have long suspected to exist, and which the experience of each successive year seems more fully to establish.

Comparing the meteorological records of the temperate zone in the two hemispheres, I was struck with the fact that *the meteorological characteristics of each season in the northern hemisphere were invariably reproduced, in the following year, at all places similar in geographical and isothermal position and natural features in the southern hemisphere.* The question naturally arises, "Is this mere coincidence?" That, of course, I cannot answer decisively, but my impressions are in the negative. I will not enlarge on the advantage of satisfactorily proving the existence of this useful rule, but will proceed to note the most striking evidence which has come under my *personal* observation during the last fourteen years.

In the year 1852 rain fell to an unprecedented amount in almost every part of Great Britain, in some places being more than double the annual average. Similar was the weather in New Zealand in the following year, the rain-fall, at other times averaging 24 inches, being then 51 inches. The summers of 1857, 1858, and 1859 were in England remarkable for heat and drought. At Leytonstone, Essex, I several times registered a temperature of 92°, and once 93° in the shade. In the autumn of the same year I left for New Zealand, and at this place, in 1858, 1859, and 1860, experienced summers equally remarkable with those mentioned above for extreme heat and absence of rain. Next we come to the three singularly wet, cold, and stormy summers of 1860, 1861, and 1862 in England, and 1861, 1862, and 1863 in New Zealand—seasons in each hemisphere so peculiar, that, with one exception, they form, perhaps, the most forcible evidence in support of my theory. Even the late summer snow and frost of 1860 had its representative here in a wonderful snow-storm and frost in the summer of 1861. To the "exception" mentioned

above I now proceed. One great point of difference between the two climates I omitted to notice, viz. the greater mildness of the Southland winters, snow rarely lying on the ground three days, or the thermometer falling below 20° Fahrenheit. Under these circumstances I looked forward with much interest to the effect the severe frost of January 1861 would have on the winter of 1862 in Southland, especially as I had the temerity to prognosticate that a similar one would be experienced. However, my theory was most fully verified by an extraordinary snow-storm, followed by an equally extraordinary frost, the snow lying on the ground for *three weeks*, the thermometer falling below 20° on fourteen successive days, and once being as low as 9° at 4 feet, and ½° on the grass. Thus each peculiar season in England has had its representative here in the next year, viz. the wet and cold years 1852, 1860, 1861, and 1862; the hot and dry 1857, 1858, and 1859; the summer of 1860 and 1861, and the great frost about Christmas 1860. Such is the result of my own observations briefly sketched; unfortunately my distance from England precludes my carrying my investigations to the extent I should wish, and my six years' exile has prevented my keeping pace with the literature of the day, so that I am really not even aware whether I be the first to propound the above theory, or whether anyone has anticipated me. In either case I am most desirous of obtaining, and shall thankfully receive, any information which may throw light on the subject, as a foreknowledge of any remarkable season would be very valuable to every colonist. Also I should wish to know the *reasons* (or rather *causes*) assigned by men of scientific knowledge and standing, such as compose the British Meteorological Society, for this curious rule (I do not admit it to be a coincidence). My own ideas are hardly worth communicating, as they are founded on mere hypothesis, whose correctness there has not yet been time to prove.

(I trust the "case" I have endeavoured to state will receive consideration in all its bearings, and that the theory may be either satisfactorily confirmed or fully disproved: I shall be glad to receive a letter on the subject. The departure of the mail compels me to postpone further remarks on the climate in general, and on the cyclones and earthquakes so frequent during the last two years, also on the Aurora Australis, and other magnetic phenomena, to another opportunity.)

No. II.

The chief points of interest in treating of this climate are,—1st, its great similarity to that of the South of England; and 2ndly, the apparent connexion between the northern and southern hemispheres by some atmospheric tide, as exemplified in the "succession of seasons" described in my last. The comparison of meteorological observations in places so much alike in situation in their respective hemispheres can hardly fail to produce important results. I must not, however, omit to notice one great difference in geographical position between the "Britain of the North" and the "Britain of the South," viz. that the former stands in the centre of a hemisphere of *land*, the latter of *sea*—a fact accounting for the greater mildness, both in summer and winter, of the latter. Its peculiar features are few, and will be best understood by a brief sketch of the seasons in rotation. The state of the weather is, of course, chiefly determined by the direction of the wind. It may be divided into two great divisions —the N.W. wind, fine, but preparing to rain, and W., when it is wet at first, but gradually clears; the wind during three-fourths of the year blows between these two points. But settled weather is rarely experienced during their continuance; a drought in summer or a long frost in winter requires, the former a S.E. wind, the latter an easterly wind, and no really settled weather (whether hot and dry in summer, or dry and frosty in winter) occurs except with the wind in one or other of these two points. From N., N.E., S., or S.W., the wind hardly ever blows. The great peculiarity of this climate is the N.W. wind, which I have partially described in a former letter. Taking its rise in the arid sandy plains of Central and Northern Australia, it crosses the S.E. part of that continent as the dreaded "hot wind"—a far more formidable affair than the European "sirocco." Intensely dry and warm, on reaching the Pacific Ocean, it instantly absorbs water with great rapidity, and on arriving at the western shores of New Zealand is completely saturated. Coming in contact with the Southern Alps (a lofty mountain-chain covered with perpetual snow), the moisture is precipitated in deluges of rain which cause that part of the Middle Island to be almost uninhabitable. Deprived of its humidity, but retaining its high temperature, greatly modified, of course, by its passage over the Pacific, the "North-western" crosses the southern parts of New Zealand as a hot dry wind. When light, its high temperature is not so perceptible, as it is then probably of more local origin, but when stronger than

"moderate," and especially when blowing a gale, the heat and dryness are intense, the thermometer sometimes rising to 95° in the shade, and the relative humidity decreasing to 35. The appearance of the sky and clouds is most extraordinary, and unlike anything ever seen in England. When the North-western has blown itself out, it shifts to W.N.W., with light wind and rain; then suddenly comes a squall from S.W. settling into a westerly wind. The westerly gales are generally accompanied by squalls of rain, hail, or sleet, with 5-minute intervals of brilliant weather. They are also attended with much thunder and lightning in the *winter* —*summer* thunder-storms (like those of England) being rare. The Easterly is a winter wind, with cloudless sky and hard frost; the S.E. a summer wind, with drought and heat: and these two winds sometimes blow for weeks together in their respective seasons, generally winding up with a North-western followed by a westerly gale with the usual accompaniments. Occasionally a twenty-four hours' fall of rain or snow occurs from S.E., but very seldom. Gales from E. or S.E. are rare. Another curious feature in this climate is the invariably highly electrical character of the wind when from *E.S.E.* or *W.N.W.* No regular thunder-storms (as distinguished from the squalls accompanying a gale) ever take place except with one of these winds; and whenever the wind is in either point, some discharge of electricity is *certain* to take place. They are, in fact, wholly eccentric and apparently capricious in their nature, and are, in spite of their comparatively rare occurrence, almost as important as the N.W. wind in their influence on the weather, and quite as curious and interesting a subject for study and investigation. I proceed to describe the rules which appear to usually govern the rotation of the seasons and the cause of the weather.

Spring commences about the middle of August, with strong gales, and squally, unsettled weather, which continues, more or less, till the end of September, when the equinoctial gales occur. On their termination summer begins, and lasts till the gales at the autumnal equinox. The summer is more properly divided into *two* seasons—the "*dry* season" (continuing to the solstice, with its accompanying gales), and the "*hot* season," from that time till the equinoctial gales at the end of March, which usher in the "*wet* season" or autumn (spring being the "*stormy* season"): heavy rains and high wind are then the rule until the winter or "*cold* season," constituted by June, July, and part of August. To these general rules there are, of course, numerous exceptions, the dry

and wet seasons, &c. changing places and visiting all parts of the year with the utmost impartiality; and, speaking from experience, I should be disposed to remark that those who stigmatize as "changeable" the English climate, can certainly never have realized in its fullest sense (as exemplified by the New Zealand climate) the truth of the proverb, "Variety is charming." It is a singular circumstance that the average of six years gives each month very nearly the same rain-fall, viz. about 3 inches. January varies from 0·31 inch to 5·52 inches; February, from 0·32 inch to 8·14 inches; March, from 2·42 to 5·45 inches; April, from 0·40 inch to 6·05 inches; May, from 0·01 inch (chiefly dew and fog) to 9·92 inches; June, 1·09 to 8·76 inches; July, 0·21 to 8·41 inches; August, 1·79 to 8·92 inches; September, 0·19 to 4·35 inches; October, from 0·47 to 5·29 inches; November, 0·52 to 4·44 inches; December, 0·28 to 7·61 inches. It falls on days varying from 2 to 20 in January; 4 to 19 in February; 5 to 21 in March; 1 to 22 in April; 0 to 27 in May; 3 to 25 in June; 4 to 24 in July; 5 to 17 in August; 1 to 15 in September; 3 to 25 in October; 3 to 20 in November; 1 to 27 in December. All this variety is within my six years' experience, and speaks more as to the nature of the climate than anything else I could say. Its principal feature is its uncertainty and changeableness; still, in spite of all objections, there is probably not a more salubrious climate on the face of the earth: the children are especially healthy; and I believe the percentage of deaths is smaller than that of any other British Colony.

LXXXVIII. *Meteorological History of Southland.* By C. R. MARTEN, Esq.

(THE following history of the weather during the last six years will give a better idea of this climate than any description, and will also serve as a standard of comparison with my future observations, saving me the trouble of writing them in full each month. I should wish them to be preserved, that in the event of any accident to my papers here, I might not wholly lose the result of six years' labour.)

The winter of 1858* was remarkably fine, with rather a mild

* In June and July 1858 there are several days missed, as I exclude them from my regular Tables. For a similar reason the barometrical readings are not recorded till 1863, as also the hygrometer.—C. R. M.

temperature and light winds, which blew almost uninterruptedly from the eastward. The spring did not begin till the middle of September, when the equinoctial gales set in, and continued till the close of the month. Their violence was often very great, particularly on the 20th, 27th, and 28th from W.N.W. to W.S.W., and on the 23rd, 24th, and 29th from N. to N.W. One of the squalls on the 28th was very remarkable; it was accompanied by repeated flashes of intensely vivid lightning right overhead, with tremendous thunder; hail fell to the depth of 2 inches, the stones being ½ inch in diameter: it lasted about twenty minutes. Fine weather then prevailed, without any excessive heat, till December. An extraordinary fall of rain (3·12 inches) occurred on the 22nd of October. The mean temperature of the first week in December was 74°·9, and of the third week no less than 76°, the thermometer frequently rising above 90° in the shade. The 21st was the hottest day I have ever recorded; the mercury stood at 98° in the shade, and remained above 90° for six hours; the maximum in sunshine was 130°. Hot dry weather continued to the end of March 1859. Heavy thunderstorms took place on the 21st of January and on the 7th of February; a solar halo on the 24th of January; and on the evening of the 7th of March a violent thunderstorm, remarkable for the variety of form and colour displayed by the lightning, of which 250 flashes were counted in an hour. That in the N.W. was red or rose-coloured, in the S.W. brilliant yellow, and in the S.E. blue. Both "brush" and "chain" lightning were seen, and one magnificent discharge of globular lightning, deep crimson in colour, followed by a report like that of a cannon: there was but little rain. From the autumnal equinox to the middle of May there was a continuance of wet and stormy weather, including a severe gale from the W. on the 17th of April. The latter half of May was fine and dry: a lunar rainbow and several yellow meteors were visible on the 20th. June was mild, but showery: a heavy fall of snow (3 inches) occurred. During July and August the weather was magnificent in the extreme: only ·21 inch fell in July, and only ·09 inch in the first three weeks of August. A severe frost took place in July, the minimum readings of the coldest days being respectively 17°, 15°, 12°, 18°, and 14°; a heavy snowstorm from S.E. on the 29th of August, when the "spring gales" came on, and ended on the 4th of September; and from that time there was extreme drought and great heat till the 26th of January 1860. Splendid auroræ australes were visible on the 2nd of September and on the 18th of October. During ten days in October a succession of furious hurricanes

from N.W. were experienced, which caused great damage over the country. There was also a heavy westerly gale on the 25th of December. Violent N.W. gales also occurred on three days in January, on the 26th of which month 2 inches of rain fell in nine hours. Dry brilliant weather was then experienced till May: gales blew from the W. on the 27th, 28th, and 29th of February, and from the N.W. on the 26th of March. Rain only fell on one day in April; a slight aurora was visible on the 18th. Torrents of rain fell during May; on the 7th, 8·17 inches were registered. A terrific W.N.W. gale took place on the 14th. June was fine and dry; a severe frost occurred—minimum reading 14°; an aurora visible on the 30th. July very mild, but excessively wet; a S.E. gale, with snow, on the 22nd and 23rd. In August the bad weather reached its climax: during seventeen days there were constant storms from the westward, with unprecedented quantities of rain and snow; the latter on seven days; thunder on ten days; auroræ australes on three days; zodiacal light very clear: only one slight frost in the month. On the 21st of August commenced the most extraordinary drought on record in this country. During the six months ending February 28, 1861, only 3·47 inches of rain fell. The heat was also very great from first to last, and the aurora australis often visible. On the 3rd of October the thermometer stood at 81° in the shade; in the evening the temperature was still very high, and light rain fell, changing suddenly to heavy *snow*, which, at 10 P.M., lay 4 inches deep—the heaviest fall we have had. From the 5th of October to the 14th of November no rain was registered. On that day there was a severe thunderstorm; lightning very vivid overhead, and rain tremendous—1·02 inch in an hour. As will be seen by reference to the Tables, the heat was intense: the maxima of the 13th, 14th, and 15th of December were 90°, 93°, and 95° respectively. A furious hurricane from E. to S.E. occurred on the 20th of December, and very severe gales from N.W. on the 6th, and W. on the 16th, 17th, and 26th. During the seventeen days between the 20th of January and the 8th of February, 1861, the heat was most extraordinary, every day exceeding 80°; and on fourteen days the temperature in the shade was above 90°, the maximum being 94°; in the sunshine the reading was 134°. A terrific gale occurred on the 3rd and 4th of March, with thunder, lightning, and rain. Fine, dry, warm weather then succeeded (maximum 89°) till the 22nd of April, which is memorable for the heaviest fall of rain on record in Otago and Southland, viz. 3·24 inches; it was attended by a S.E. gale. From that time the weather was uninterruptedly fine (*no rain*

falling in May) to the 5th of June. May was the driest month I have ever registered, though, curiously enough, the wind was almost constantly from the N.W.; for the first time in three years fogs were experienced, the last and greatest being on the 26th, which preceded the first instance on my list of a distinctly marked cyclone: I have traced it throughout New Zealand, and shall describe it in a special paper on New Zealand cyclones. It was during the first half perfectly dry; but the westerly half (beginning on the 5th of June) brought with it a tremendous fall of rain. The remainder of the winter was brilliantly fine and very mild. The ensuing spring was even drier than the last, and the weather up to the end of November was extremely warm. On one day in October the thermometer stood at 29° at sunrise, and at 2 P.M. rose to 83°, giving the wonderful range of 54°. At the end of November there was a heavy snow-storm (3 inches deep), followed by a severe frost, the mercury falling to 20°. The singularity of this occurrence will be better understood when I mention that November is the representative of the English June (in temperature and weather)—December, January, and February representing July, August, and September. Thus this frost and snow came at the beginning of the "dog-days." Then came *our* edition of the English summer of 1860. Wet weather prevailed constantly up to April, when there was a short interval fine, followed by two months of constant rain, hail, snow, sleet, wind, thunder, and lightning. A solar halo on November 25; heavy N.W. gale December 4; thunderstorm December 15, another (very violent) December 25, when ·75 inch fell in half an hour; heavy W. gale next day; another, February 8 and 9; another (followed by a smart shock of earthquake), June 12; another on the 16th and 17th of June; on the 5th of July a heavy snow-storm commenced, the severest frost ever known in this country: according to the Maories and old whalers, nothing has ever been seen like it before —at any rate in the last twenty years. On fourteen consecutive days the thermometer was below 20°, and on the 12th, 13th, and 16th it decreased to 10½°, 10°, and 9° respectively; on the 17th to 11°. Fine mild weather till the end of September. Heavy N.W. gales on the 25th of August and 22nd of September. Throughout the whole of October, November, and December there was a continuance of fearful weather; hail, rain, and snow, in torrents, on twenty-five days in October, twenty in November, and twenty-seven in December. Violent W. gales on the 3rd, 5th, 20th, and 23rd of October, 8th, 10th, and 19th of November, and 7th of December; and N.W. on the 15th and 18th of Novem-

ber and the 13th and 24th of December. On the night of the 24th the fury of the hurricane was unprecedented; it was accompanied by intensely vivid lightning of a peculiar crimson tint, wholly without thunder. January 1863 was fine and warm, but windy beyond all precedent; the gales from the N.W. on the 4th and 26th, and from the W. on the 6th and 10th, were tremendous; the thermometer rose to 90° on the 26th. February was similar; thermometer 80° on the 3rd; furious N.W. gales on the 2nd and 5th. Thunderstorms occurred on the 2nd, 3rd, 5th, and 6th of December, the 28th, 29th, and 30th of January, and the 3rd and 28th of February. The two latter, with that of December 2, were the most severe I have seen in New Zealand. In that of December 2, nearly an inch of rain fell in 45 minutes: the lightning was very brilliant; it continued off and on for several hours. That on the night of February 3 lasted nearly four hours; the thunder and lightning were terrific. That on the night of the 28th of February was preceded by a fine *double* lunar rainbow; it lasted two hours, in which time there were nearly 1200 flashes of lightning. From that date to the present, wet and stormy weather has continued without intermission, *i. e.* fifteen months.

A heavy N.W. gale on the night of March 7; another from W., March 23rd, 24th, and 25th; and another from N.W. on March 29th. During the first week of April there were unmistakeable indications of an approaching tempest. On the 6th it commenced, and continued with unparalleled fury for *nineteen days*. It reached its climax during the 19th and 20th, which transcended anything in previous experience. The 19th was the worst; the rain, hail, snow, sleet, thunder and lightning, with the furious wind, far surpassed anything ever approached in England. Trees were torn up in numbers, houses unroofed, and even a plough blown over in spite of the small hold and great resistance it offered to the wind. At 3.10 P.M. there was a brilliant flash of lightning, instantly followed by a report like a cannon and then a long continuous roar. Three minutes afterwards there was so awful a discharge of electric fluid right overhead, that the houses appeared enveloped in a vivid red flame; precisely at the same moment came an appalling crash of thunder, causing the house actually to crack and vibrate as if from an earthquake. Another heavy gale (W.) occurred on May 2nd and 3rd; a severe frost (17°) on May 11th; on the 31st the maximum was 39°; the temperature of the two latter days was no less than 17° below the average of five years. Another heavy westerly gale on June 4th and 5th; on the evening of the latter day it suddenly fell calm,

and at 10.25 P.M. occurred the severest shock of earthquake ever experienced in the south. I shall describe it fully, with the peculiar meteorological features accompanying, in a special paper. I should notice that the barometer remained about 30 inches, without being affected either by the earthquake or the gale and rain. The earthquake was followed by a furious northerly gale, a fall of 2·017 inches of rain in four hours and a half, several curious fogs, &c. A violent easterly gale on the night of July 8th, and another from W., N.W., and N. successively on the 10th, 11th, and 12th. Towards the end of August the barometer rose steadily for a considerable time, till it reached 30·24 inches. The rise was followed by twenty-four hours' incessant heavy rain from E. During the morning of September 8th, it blew a gale from E., the temperature 43°, humidity 97 ; at 3 P.M. it suddenly moderated and veered right round to N.W., the thermometer rose 20°, the humidity decreased to 68, and the barometer fell half an inch; heavy rain followed. The last four days in September were intensely dry, the humidity once decreasing to 39. Heavy fall of rain on October 14th, 2·008 inches (E. wind). Furious easterly gale on October 27th and 28th, preceded by a rise in barometer. On the 20th of November, the barometer, after being generally below 29 inches for weeks, decreased to 28·74 inches. Throughout the whole week there was continual thunder and lightning, sudden showers with clear sky, frequent and remarkable fluctuations in reading of instruments, &c. On the 20th of November the barometer reached its lowest, 28·74 inches; and at 11.30 P.M. there was a smart shock of earthquake. Violent gale from W.N.W. on November 28th; a thunderstorm on the 15th of December. The weather since December 31st, 1863, is described in my successive monthly reports. It has been in the last degree unfavourable. Constant rain and wind. The month just concluded (May), however, far surpasses anything in precedent experience. April was more remarkable for a continuous drizzle than for heavy rain. The storm of the 29th was peculiar, from the frequent fluctuations of the instruments. One flash was truly awful, and only approached by that of the 19th of the previous April, the thunder equally terrible; and the effect on the house was quite that of an earthquake. The colour was, as before, red. During the week of fine weather in the middle of April, there were dense night fogs.

TABLE showing Monthly Meteorological
at Southland,

Year and Month.	Barometer. Mean Pressure. Not reduced.	Hygrometer. Relative Humidity 0—100. By Dry- and Wet-bulb Thermometer.	Thermometer in the Shade. Extremes. Maximum.	Extremes. Minimum.	Mean Temperature.	Days Thermometer stood Above 80°	Above 90°	Below 32°	Below 20°
1858.			°	°	°				
September ...	......	......	67	31	48·5	0	0	2	0
October	......	......	75	37	54·7	0	0	0	0
November ...	......	......	82	36	58·3	3	0	0	0
December ...	......	......	98	42	65·8	15	5	0	0
1859.									
January	......	......	92	43	66·4	14	2	0	0
February ...	......	......	90	41	62·2	9	1	0	0
March	......	......	84	39	58·6	2	0	0	0
April	......	......	76	37	54·2	0	0	0	0
May	......	......	66	28	49·4	0	0	3	0
June	......	......	64	25	43·1	0	0	9	0
July	......	......	59	12	39·9	0	0	10	6
August	......	......	63	20	42·0	0	0	9	0
September ...	......	......	70	26	49·7	0	0	4	0
October	......	......	79	39	56·9	0	0	0	0
November ...	......	......	87	44	60·0	6	0	0	0
December ...	......	......	89	44	61·3	6	0	0	0
1860.									
January	......	......	88	47	63·7	8	0	0	0
February ...	......	......	91	43	60·1	4	1	0	0
March	......	......	85	34	60·2	5	0	0	0
April	......	......	80	27	55·5	1	0	1	0
May	......	......	68	29	51·2	0	0	3	0
June	......	......	58	14	39·2	0	0	7	3
July	......	......	60	17	42·2	0	0	5	2
August	......	......	62	25	44·0	0	0	1	0
September ...	......	......	71	24	51·0	0	0	2	0
October	......	......	81	39	57·0	1	0	0	0
November ...	......	......	86	46	61·1	4	0	0	0
December ...	......	......	95	45	67·6	17	4	0	0
1861.									
January	......	......	94	43	65·4	16	7	0	0
February ...	......	......	92	40	67·6	14	7	0	0
March	......	......	89	43	60·5	6	0	0	0
April	......	......	84	27	54·5	2	0	2	0
May	......	......	73	28	48·6	0	0	4	0
June	......	......	62	20	43·9	0	0	8	0

Elements from September 1858 to May 1864, New Zealand.

Weather.				Wind.							
Days no Rain.	Showery Days.	Days wet throughout.	Total Rain on surface of ground.	N.E.	S.W.	N.W.	S.E.	N.	S.	E.	W.
			inches.								
17	12	1	4·020	0	5	5	1	1	0	8	10
22	7	2	4·470	0	0	6	7	2	0	1	14
20	9	1	2·820	0	4	5	7	0	7	0	7
24	4	3	2·560	0	3	7	12	0	0	3	6
27	4	0	0·690	1	3	16	7	0	2	6	3
21	6	1	2·210	0	3	6	3	0	2	2	11
25	5	1	2·830	0	0	4	3	1	0	5	18
15	15	0	5·960	0	3	11	0	0	1	0	15
21	10	0	2·100	1	1	13	1	0	0	5	9
17	13	0	2·450	0	1	14	0	1	2	0	12
27	4	0	0·210	0	0	17	4	0	0	6	4
26	4	1	1·790	0	1	18	1	0	0	7	5
22	8	0	1·910	0	1	8	6	0	3	5	7
27	4	0	0·470	0	0	20	6	0	0	2	3
25	5	0	0·520	0	0	10	5	0	0	1	12
26	4	1	1·580	1	0	8	11	0	0	2	10
26	5	0	2·770	0	0	9	6	1	1	2	12
25	4	0	0·320	0	0	4	4	1	0	4	16
26	5	0	2·420	0	0	9	8	0	0	2	13
29	1	0	0·400	0	0	19	1	0	0	0	10
20	11	0	8·240	0	2	20	1	1	0	4	3
27	1	2	1·090	0	0	14	1	0	0	14	1
21	7	3	4·880	0	0	7	8	1	2	12	1
14	15	2	8·920	0	2	9	4	0	2	0	14
28	2	0	0·190	0	0	10	5	0	0	9	6
28	3	0	0·940	0	0	11	17	0	0	0	3
27	3	0	1·250	0	0	2	16	0	0	6	6
30	1	0	0·280	0	0	4	17	0	1	2	7
29	2	2	0·310	0	1	3	20	3	0	2	2
24	4	0	0·560	1	0	7	14	0	0	0	6
23	8	0	4·340	1	0	17	3	0	0	1	9
23	5	2	4·780	0	0	12	6	0	0	2	10
31	0	0	0·010	0	0	22	1	0	0	7	1
22	4	4	5·620	0	0	12	1	0	0	8	9

TABLE showing Monthly Meteorological
at Southland,

Year and Month.	Barometer. Mean Pressure. Not reduced.	Hygrometer. Relative Humidity. 0—100. By Dry- and Wet-bulb Thermometer.	Thermometer in the Shade. Extremes. Maximum.	Extremes. Minimum.	Mean Temperature.	Days Thermometer stood Above 80°	Above 90°	Below 32°	Below 20°
1861.			°	°	°				
July	......	......	54	20	40·3	0	0	9	0
August	......	......	61	21	43·9	0	0	9	0
September ...	......	......	70	26	53·2	0	0	1	0
October	......	......	83	29	54·5	1	0	2	0
November ...	......	......	83	20	56·5	5	0	1	0
December ...	......	......	87	40	62·6	10	0	0	0
1862.									
January	......	......	84	44	61·9	7	0	0	0
February ...	......	......	84	48	62·4	3	0	0	0
March	......	......	80	33	57·9	1	0	0	0
April	......	......	63	24	48·2	0	0	5	0
May	......	......	68	20	44·5	0	0	13	0
June	......	......	55	17	41·2	0	0	9	2
July	......	......	52	9	34·1	0	0	25	14
August	......	......	62	20	41·3	0	0	14	0
September ...	......	......	65	23	50·1	0	0	6	0
October	......	......	74	34	53·8	0	0	0	0
November ...	......	......	79	44	59·2	0	0	0	0
December ...	......	......	79	39	59·3	0	0	0	0
1863.									
January	......	......	90	34	61·4	7	1	0	0
February ...	......	......	89	27	58·4	4	0	3	0
March	......	......	77	31	55·2	0	0	2	0
April	......	......	75	30	46·5	0	0	4	0
May	......	......	65	17	44·1	0	0	11	1
June	......	......	64	21	38·0	0	0	15	0
July	......	......	56	24	42·6	0	0	7	0
August	......	......	58	24	44·0	0	0	7	0
September ...	29·675	64	72	26	52·7	0	0	2	0
October	29·616	68	71	31	50·1	0	0	2	0
November ...	29·403	65	74	32	56·0	0	0	0	0
December ...	29·673	78	82	38	57·3	2	0	0	0
1864.									
January	29·611	71	82	43	58·9	2	0	0	0
February ...	29·775	79	81	41	57·8	1	0	0	0
March	29·872	75	77	33	53·4	0	0	0	0
April	29·844	81	74	34	52·5	0	0	0	0
May	29·631	76	62	30	46·6	0	0	3	0

Elements from September 1858 to May 1864, New Zealand.

Weather.				Wind.							
Days no Rain.	Showery Days.	Days wet through-out.	Total Rain on surface of ground.	N.E.	S.W.	N.W.	S.E.	N.	S.	E.	W.
			inches.								
27	4	0	0·830	0	0	13	2	0	0	11	5
23	6	3	2·190	0	2	15	5	0	0	3	6
26	4	0	0·980	0	0	12	8	1	1	3	5
27	4	0	0·760	0	3	9	11	0	0	1	7
26	4	0	0·950	0	2	6	13	0	0	3	6
17	14	0	6·170	0	1	13	11	0	0	1	5
12	19	0	5·520	0	0	7	11	0	0	0	13
16	10	2	2·800	0	0	6	12	2	0	0	8
20	10	1	2·980	0	2	9	13	4	0	0	3
27	3	0	0·590	0	0	9	5	2	1	7	6
14	12	5	5·400	0	0	14	5	0	0	5	7
5	20	5	8·760	0	0	14	1	2	0	1	12
27	4	0	0·770	4	2	15	1	0	0	5	4
22	9	0	2·250	1	0	9	3	0	0	12	6
22	5	3	1·600	0	0	16	0	0	0	7	7
6	20	5	5·070	0	2	6	4	0	0	3	16
10	17	3	3·910	1	0	10	5	3	2	1	8
4	25	2	7·610	0	0	7	6	2	2	2	12
24	6	1	2·310	0	0	10	5	2	0	5	9
20	8	0	2·730	0	0	6	19	0	0	1	2
14	15	2	5·200	0	1	13	3	0	0	0	14
9	17	4	6·050	0	0	12	1	1	1	1	14
18	12	1	3·970	0	0	17	0	1	1	6	7
20	10	0	4·390	1	1	10	0	1	0	7	11
7	20	4	8·414	0	0	8	2	10	2	3	6
14	13	4	7·176	0	0	8	2	2	0	2	7
15	13	2	4·355	0	1	12	5	0	0	1	11
18	11	2	5·293	0	1	10	8	0	2	6	4
12	18	0	4·441	0	0	17	10	0	0	3	0
14	16	1	3·696	0	1	8	8	0	3	3	8
11	20	0	3·899	0	1	20	4	0	0	4	2
10	15	4	8·145	0	0	4	9	0	0	2	14
10	17	4	5·455	0	0	6	7	2	0	0	16
8	18	4	3·955	0	0	4	7	2	0	5	12
4	23	4	9·923	0	0	9	2	0	0	0	20

LXXXIX. *Natural-History Notes.* By T. A. Preston, Esq., Marlborough College. In a Letter to Mr. Glaisher.

Snowdrops were above ground as early as January 18th, when a few were so far advanced as to have their buds hanging down; but the cold weather retarded them very much. On the 9th of February they were *generally* in bud, but not out. This continued till the 20th of February, when the warm weather rapidly brought them forward.

Crocuses.—Remarkably late, only just appearing above ground on the 20th of February. A few yellow ones were in bud on the 24th.

Lilac.—On a warm terrace a few green buds appeared, which have since increased in numbers.

Winter Aconite (*Eranthis hyemalis*) was in flower by February 9th.

Ornithogalum umbellatum. *Arum maculatum.* Daffodil (*Narcissus Pseudo-narcissus*).	All just appearing above ground on February 20th.

Elder.—Young leaves by February 24th.

Hazel.—Leaf-buds nearly bursting. Male catkins nearly out, a few quite so, February 24th.

Viburnum Lantana.—Flower-buds appearing February 24th.

Elm.—Flower-buds appearing, February 24th.

Scilla bifolia.—Above ground; one flower out in a warm spot on February 27th.

Vegetation has been greatly delayed by the cold weather. This time last year crocuses were in full flower, some nearly over.

Scarlet Ribes.—Flower-buds appearing, February 28th.

XC. *Some Effects of the Cold of January.* By T. A. Preston, Esq., of Marlborough College. In a Letter to Mr. Glaisher.

On the 28th of January, Tavernoke Forest presented a wonderful sight. The icicles were hanging from the trees in such numbers that almost every beech (of which there are large numbers) and birch was more or less damaged, besides many hawthorns. The broken boughs are not yet (March 3) all cleared away, though men have been constantly at work ever since. Among the more remarkable instances may be mentioned a beech tree which was split down the whole way to the roots (the trunk must have been 8 feet in circumference); one half was entirely wrenched off and

formed a regular arch overhead. A hawthorn may also be mentioned, which had been split down to the roots, the several parts of the tree being spread out in the form of a star. Most of the birch trees had had their tops entirely broken off, besides having many large boughs either wholly or partially destroyed; a few were even left with bare poles. The damage done to these trees, of which there were many very fine specimens, has been very great, and it will be many years before this part of the forest will present its formerly beautiful appearance.

XCI. *On the Storm which was so severely felt in the more Northern Counties during the Night of the 5th of January.* By A. FORBES, Esq., of Culloden. In a Letter to Mr. GLAISHER.

THE barometer, which had been ranging low during the 2nd, 3rd, and 4th, fell rapidly after 9 A.M. on the 5th; and the following are some of the principal oscillations recorded from the standard instrument, both before and during the height of this storm:—

Barometer 104 feet above the sea, and corrected to 32° Fahr.

1865.		in.
January 5	9 A.M.	29·556
" "	6 P.M.	29·376
" 6	2 A.M.	29·068
" "	4 A.M.	29·073
" "	9·30 A.M.	29·368
" "	6 P.M.	29·765

"The weather during the 2nd, 3rd, and 4th continued boisterous, with heavy showers of sleet and snow, accompanied with lightning. On the morning of the 4th the wind blew from the W. to W.N.W. with a force equal to 16 lbs. on the square foot. But this was far exceeded on the 6th; for at 2^h, $3^h 20^m$, $4^h 35^m$, and $6^h 10^m$ on the morning of that day the maximum forces recorded ranged between 25 lbs. and 30 lbs. on the square foot, the direction of the wind being at the time from W. to W.N.W.; and it is somewhat remarkable that all the greatest forces of wind recorded in the Culloden observations have been found to occur during the time the wind is rapidly veering to the right, across the W. to the W.N.W. points of the compass. Judging from the various accounts received from both Sutherland and Caithness, and the

greater depression of the barometer there, it may be conjectured that the centre of this storm passed over considerably to the north of Inverness."

"This month has been remarkable for a great depression of the barometer, and the lowness of its mean height. Snow fell on no fewer than thirteen days, but to no greater depth than from 2 to 3 inches on the low ground. The frost in some of the nights was very intense; and burns and some rivers (such as the Nairn) became completely frozen over. The average temperatures of the 1st and 26th days were only 21°·5 and 21°·9 respectively, and that for the whole month 34°·19. The years 1847, 1848, and 1850 were all noted for the coldness of January; but the mean of this month in the present year is the lowest that has occurred since 1841, when it was 33°·91."

"The aurora borealis was visible on no fewer than eight nights during the month, and on some occasions it was very brilliant and beautiful. This was particularly the case on the night of the 25th, when its bright 'streamers' played over the whole of the northern sky, and shot upwards in rapid waves, like flashes of sheet lightning, towards the zenith, two meteors being seen at the same time in the N. and W.N.W., and within the limits of the aurora."

"There were gales of wind on the 4th, 6th, and 30th, that on the last-mentioned day being accompanied by a severe storm of snow and heavy drift in the highlands, blocking up roads, thickly covering over fields, and filling "cuttings" on the Inverness and Perth line of railway to a depth of 30 feet."

XCII. *On a Peculiarity in a Cyclone.* By W. R. BIRT, Esq. In a Letter to Mr. GLAISHER.

I HAVE received an account of a cyclone in the Indian Ocean, from Captain Breary, of the ship 'York,' now lying in the East India Docks, containing the following passage, which may probably interest you:—

"There was no indication whatever, beyond what the barometer gave, of the storm coming on: no lightning was seen, no heavy banks or lurid streaks of light. The wind gradually freshened up like an ordinary gale, with rain, until it become all round quite black. The sea was regular but agitated, and rose up suddenly into pyramidal heaps, and fell as suddenly."

The barometer fell from 30·10 inches to 28·92 inches in forty-eight hours; wind during the whole time from E. Captain Breary

records a calm of about four hours, after which the shift of wind was W.; it soon became N.W., with a rising barometer. Lat. about 25° S., and long. about 84° E.

XCIII. *On the Aurora of* 1865, *February* 17. By A. S. Herschel, Esq. In a Letter to Mr. Glaisher.

On Friday night, the 17th ult., the "northern lights" were seen here in unusual splendour. One observer described the appearance between 8 o'clock and half-past 9 o'clock P.M. as if the sun were rising in the N.W. Another observer made to me the following verbal communication: — "The aurora was brightest between 8 o'clock and 10 o'clock P.M. At $10^h\ 30^m$ it had absolutely disappeared. It resembled the glow of dawn *in the N.W. only*, rising to a height of 30°, and sufficiently light to read print. There was a *perfect absence of vertical rays* during the whole time of its visibility." This observation sufficiently shows that a mass of auroral light was visible in Kent above the N.E. horizon between 8^h and 10^h P.M. on the night in question, extending from the horizon to 30° of altitude, and absolutely disappearing before $10^h\ 30^m$ P.M. The following extract from a daily newspaper (the 'Northern Ensign') shows that the aurora seen was vertical at Wick in Caithness, more than 500 miles distant from this place:—

"Seldom has the aurora borealis been seen more beautiful or brilliant than on Friday evening at Wick (the 17th of February), where its extraordinary movements, shapes, and colours attracted great attention. Shortly before 8 o'clock it seemed to congregate itself into one magnificent arch, which spanned the centre of the heavens, and now and then threw off fantastic auroræ of every conceivable shape and colour, which faded away and were soon followed by others equally beautiful and varied. Later in the evening the arch assumed a purple colour, and gradually disappeared."

The horizon-line at Hawkhurst intersects the vertical at Wick at a distance of thirty-six miles from the earth. It is therefore difficult to suppose that the auroral arch seen at Wick had a smaller altitude than this above the earth. At the same time it may have extended higher.

The aurora reappeared and continued all night at Wick "in wonderful magnificence," disappearing only in the morning, but in the N.E. quarter of the heavens; and this display was not seen at Hawkhurst.

BOOKS AND NOTICES.

XXVII. *British Rainfall*, 1864.—*On the Distribution of Rain over the British Isles during the year* 1864, *as observed at about* 900 *stations in Great Britain and Ireland* (with Illustrations). Compiled by G. J. Symons. London: Edward Stanford.

A note on the back of this bulky pamphlet gives the number of pages in each of its predecessors, and affords a rough, but perhaps truthful, index of the development of the investigations to which Mr. Symons has so thoroughly devoted himself. From it we find that the numbers run thus:—1860, 4 pages; 1861, 18; 1862, 25; 1863, 48; 1864, 80. In an early number of these 'Proceedings' we gave a Table showing the number of stations in each of the divisions in which the stations are arranged; we do not think it necessary to do so on this occasion, but prefer pointing out some of the leading points of progress which the present annual exhibits. In the first place, we note the insertion of the records of rainfall at the lighthouses round the Scottish coast, made under the supervision of the Board of Northern Lights; secondly, that the 'Monthly Circular' has been extended to double its previous size, and contained, in 1864, returns from 40 stations (England and Wales 20, Scotland 10, Ireland 10), and copious remarks on the weather, on crops, auroræ, halos, &c.; thirdly, that the gauges supplied by the grant of the British Association are filling up the blank districts of England, so that there is now, apparently, hardly any part of England distant 10 miles from one of Mr. Symons's observers.

Two maps at the beginning of the pamphlet show the position of new gauges in Cumberland and in North Wales. The former have been erected (by and at the sole cost of Isaac Fletcher, Esq., F.R.S., of Tarnbank), in the vicinity of that very rainy place Seathwaite in Borrowdale, and are calculated not only to confirm, but to carry further the deductions of the late Dr. Fletcher Miller, F.R.S.; for Mr. Miller had not confined his operations to easily accessible places or to moderate altitudes, but boldly seized the most salient points, even planting gauges on Great End, 3000 feet, and Scawfell Pike, 3200 feet above the sea. In fact, this last is the highest point in England. But we need not remind those who are up in the subject of mountain rainfall that, in districts like Borrowdale, the fundamental law of increased rain-fall at elevated stations does not hold good. It will not, perhaps, be amiss to illustrate this by the returns herein given for 1864.

Rain-fall in Borrowdale, 1864.

Station.	Height above sea.	Depth of rain.
Wastdale Head	247	86·78
Stonethwaite	330	100·76
Seathwaite	422	134·67
Brant Rigg	695	76·21
Stye Head Tarn	1472	108·73
Sprinkling Tarn	1985	119·52
Scawfell Pike	3200	73·20

It is obvious there is here no connexion between altitude and depth. We may note here parenthetically and by way of contrast that in Norfolk and that part of England there were nearly a dozen stations with less than 15 inches of rain in the whole year, or less than one-ninth of that which fell at Seathwaite.

But to return to the second map. It shows the position of 25 gauges recently started round Snowdon by Captain Mathew, of Wern, Carnarvon. Reference is also made to a considerable number of gauges in West Scotland, where also rainfalls above 100 inches appear frequent; and to the starting of a solitary gauge at Killarney. We are happy to say, it is solitary no longer, as Mr. S. W. Silver has not only secured another observer, but most liberally supplied him with instruments—not merely a rain-gauge, but thermometers also.

Under the head of "Rain-gauges and hints on observing them," two or three pages of useful information are given, with engravings of several forms of rain-gauges, and remarks on their advantages and defects. Crossley's, as might be expected, is condemned. There is, however, in this part one error, which we are astonished so regular an observer as Mr. Symons should make. In order to make the matter clear, we quote the whole sentence, and add our own comments.

"A very knotty point is the date on which a fall is to be entered. For example, on January 17th it began to rain in the afternoon, ceasing at 11 P.M.; this would of course be measured at 9 A.M. on the 18th: should it be entered against the 18th or 17th? The British Meteorological Society and Mr. Glaisher say the 18th, the Scottish Meteorological Society say the 17th.

"Believing that it is a matter on which uniformity is of more consequence than strict accuracy, I side with the former, and believe that in so doing I join a large majority of my observers; but as it is only supposition, it will perhaps be well to suspend any alteration by those who do otherwise, until the votes of the whole constituency can be taken."

In reply to this we say a rainfall ceasing at 11 P.M. on the 17th is a rainfall belonging to the 17th, and *not* to the 18th, and should never be so considered, never has been at the Royal Observatory, and never by the British Meteorological Society. The practice of an observer reading only at 9 A.M. may throw doubts, and does create a doubt, as to whether the rain has fallen on the morning alone or on the day before alone—that is, before midnight or on both days: this is usually cleared up by his notes.

At Greenwich every gauge is read daily at 9 A.M. and 9 P.M., and occasionally at midnight, and always at the end of the month; but this practice cannot be followed out generally. Some of the differences of monthly falls of rain when a heavy fall occurs on the last day of the month are probably attributable to the practice of closing the rain-register at 9 P.M. on the last day, and allowing all that falls afterwards before 12 o'clock to be credited to next month.

The pamphlet contains also the results of the experimental gauges at Calne and Castleton Moor, and the records of the

various gauges at Greenwich. As there are at Calne alone between twenty and thirty different gauges, this part of the investigation is by no means a light matter. A diagram shows the decrease in the amount collected in gauges according to their height above the ground; and it is a singular proof, both of the accuracy of the instruments and of the careful observing of Colonel Ward, that this curve of one year is as regular as though it had been based upon many years' observations.

Mr. Symons devotes several pages to a history of the weather in 1864, month by month, showing the effect on the crops of the dry summer weather, &c.; he also gives under this head a small table of some of the *least* falls in July (which we all know was very dry), from which table we find that at Arundel, Hastings, Osborne, Winchester, Hitchin, and Market Harborough they had not two-tenths of an inch in the whole month. Another little table gives the fall in October at some of the Scotch stations, at seven of which the October fall was equal to, or more than, one-third of that in the whole year, the strongest illustration being Mowhaugh, in Roxburghshire, where the yearly total was 34·75, the depth from January 1st to September 30th 15·25, and during the month of October 15·75, or half an inch more than in the preceding nine months (particulars of the floods produced by this extraordinary fall are given under the head of "Heavy falls of Rain"), together with the daily falls classified according to date, and with the percentage of each heavy fall to the yearly total—a calculation which must have involved much labour, though perhaps not so much as a table with the unassuming title of "Rainfall in 1864 compared with previous years," which gives for each of forty stations the following information:—stations, country, years of continuous observation, least rainfall before 1864, its depth and date, depth in 1864, greatest depth before 1864 and its date. From this table it appears that at thirty-two places out of the forty there are drier years on record than 1864; that 1854 was drier in England, that 1855 was drier in Scotland, and that 1858 was nearly as dry; it is in fact in the comparative drought of 1863 that the explanation of the deficient water-supply of 1864 is to be found.

Mr. Symons gives in their own words the notes of some of the observers; and these are immediately followed by what he truthfully enough calls "General Tables," giving for about 900 stations the name of station and its county, observer's name, height of the gauge above the ground and above the sea, and lastly the total depth of rain in 1864.

The work of which this and preceding pamphlets are but one portion has now been continued for five years; and for the first time Mr. Symons explains that, with the exception of a contribution of about £100 by the observers, and of £55 (to be expended in gauges) from the British Association, all the expenses have been defrayed out of his own pocket, and that in *time* and *money* he is, like other superintendents and collectors of meteorological results, several hundred pounds the poorer for his work. Mr. Symons remarks, "It is not fair to expect me to continue such a sacrifice." In this we concur; but what is to be done?

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

EDITED BY

JAMES GLAISHER, Esq., F.R.S., Secretary.

Vol. II. 1865, APRIL 19. [No. 19.

S. C. WHITBREAD, Esq., F.R.S., President, in the Chair.

J. Ingleby Mackensie, Esq., M.B., Belgrave House, Sidmouth, was balloted for and duly elected a Member of the Society.

The name of One Candidate for admission into the Society was read.

XCIV. *On the Secular Change of Temperature of the Air at Greenwich.* By A. S. Herschel, Esq.

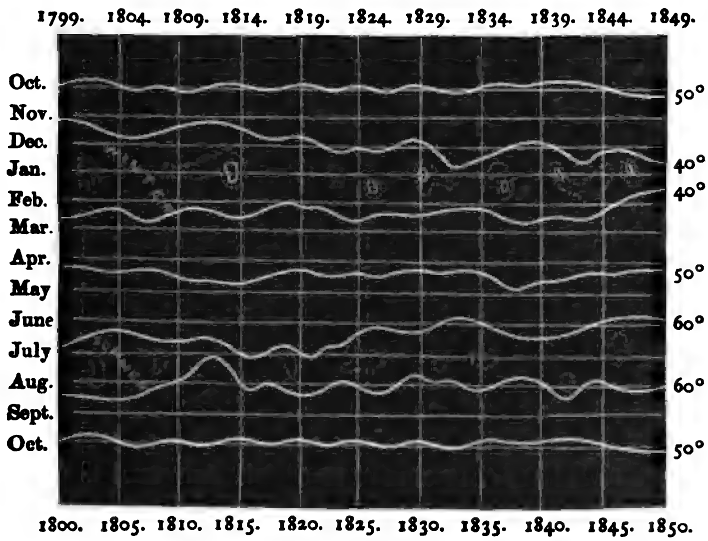
In the 'Philosophical Transactions' for 1850 (pt. 2. p. 585), Mr. Glaisher pointed out the *increasing* predominance of positive over negative signs in the difference of monthly temperatures observed at Greenwich, from their mean values, in the space of seventy-nine years. In 1850 the temperature of the climate at Greenwich seemed to have increased. The original Table (at p. 581 of the same part) to which reference is made contains the mean temperature for every month at Greenwich from January 1771 to December 1849. As the increase shown by the Table is found in Mr. Glaisher's last investigation (communicated this year to the Meteorological Society) to be most marked in the three months of

November, December, and January, when the thermometer *approaches its minimum*, a small change of the mean temperature at this season of the year may be expected to produce a considerable difference in the time of the year, and in the day of the month, when any particular mean temperature, near the minimum value, is reached. To make this change or progression of the seasons visible in a diagram, it was necessary to project all the monthly mean temperatures contained in the Table for half a century (from October 1799 to October 1850) in a continuous curve, having the current number of the month for the abscissa and the monthly mean temperature for the ordinate of the curve. The curve so obtained is 6 inches high and more than 36 feet long. Level lines, corresponding to 30°, 40°, 50°, and 60° of temperature, were ruled along the whole length of the curve, intersecting it in those points corresponding to the times, in each year, when the mean daily temperature in the year reached these values respectively. The months and decimals of a month were then read off at the corresponding abscissæ for each year and tabulated. The object being to represent the result in the form of a diagram, the months and their decimals were in the next place laid down as ordinates of a series of curves, of which the years A.D. from 1800 to 1850 are the abscissæ; and the curves represent for every year the early or late arrivals of its seasons. This diagram is represented in the figure. The curve-lines were made to pass through, or near, all the values laid down, giving equal weights to every point.

The figure shows that the mean daily temperature of 40° is reached much more rarely in the early part of December at the end of the fifty years than it was at the beginning, but more frequently at the end of December or even in January. The curve of 40° takes its origin *at the beginning of the century* in the latter part of November, but at the *end of the first half of the century* towards the latter part of December. This season has therefore retired in the year very nearly a month in fifty years. On the other hand, the season of the beginning of summer has advanced, falling in June instead of in July; but the other curves for temperature follow a nearly constant march throughout the time. The curve of 40° for the return of spring has not suffered an equal deviation with the same curve for the beginning of winter; and this agrees with Mr. Glaisher's conclusion that the increase of temperature is most marked in the months of November, December, and January. The figure also shows that the

curve of 60° for the end of summer has undergone very little change, while the duration of summer has, nevertheless, been increased by the earlier arrival of that season. The effect of the cause (whatever it may be) which produces the secular increase of temperature is, therefore, to shorten the interval between the setting in of winter and the return of summer, and to lengthen the interval between the arrival of summer and the return of winter, without altering the periods of cessation of those seasons. An increase of aqueous vapour near the ground (like that arising from improved cultivation) might be expected to produce a similar effect; for aqueous vapour, as Professor Tyndall has shown, permits an easy passage of the sun's rays, but checks radiation from the earth.

Diagram showing the earlier occurrence of Summer in Fifty Years, at Greenwich, and the later occurrence of Winter, in the middle of the present century than at the beginning.



Mem. The horizontal line opposite to each month in the figure corresponds to the middle of the month.

The black circles in the space for winter represent mean temperatures of 30°; and the dotted curves mean temperatures of 35°. In the space for summer, the dotted curves represent mean temperatures of 65°.

As, however, the cause prevails more strongly from November to January than at any other time of the year, there is reason to

believe that it is of a special and particular kind. The very remarkable break of continuity, at the end of November, in the declining branch of the curve of mean daily temperature in the year, pointed out by Mr. Glaisher in the same paper of the Meteorological Society, reaches its maximum on the 3rd day of December. It deserves consideration, whether or no this singular and prominent feature of the curve of temperature (which is unique in the latter half of the year) may not have been instrumental in delaying the return of winter, thereby producing the very considerable secular change in the mean temperature of the year. The effect of this curious feature upon the temperature of the month is occasionally very great; so that the mean temperature for December has *eleven times* exceeded that for November, in the space of fifty years, namely, three times in the former and eight times in the latter half of the period represented by the diagram. The greater prevalence of this anomaly in later years may also be inferred from the values of the mean monthly temperatures for the years 1857–63, furnished by Mr. Glaisher in the same paper of the Meteorological Society, where in seven years it occurs no less than three times, the mean temperatures for December, in the years 1858, 1861, and 1862, being greater than the mean temperature for November.

The cause of this very remarkable break in the curve of temperature at the end of November, and of the maximum which it reaches at the beginning of December, may probably be owing to the south-west currents of air setting in over the country about the same time. These currents at Greenwich reach a principal maximum in December, and only one other maximum a little stronger in July.

The other progression of the seasons, namely, the early arrival of summer, apparent in the diagram, corresponds to a very sensible maximum of the secular change, indicated by Mr. Glaisher's values of this quantity as occurring in the month of June. At this point a very remarkable maximum in the ascending branch of the curve of mean daily temperature in the year (not noticed in Mr. Glaisher's description of the Table) also takes place upon the 26th of June. The mean temperature on this day differs only two-tenths of a degree from that of the 7th of July, and eight-tenths from the mean temperature of the hottest days in the year, the 14th and 15th of July. But in June and July the south-west current reaches a second maximum of force at Greenwich somewhat larger than that in December. The inference from the dia-

gram, and from the seasons of the greatest secular change of temperature in the year, is, therefore, that these currents of the air, which constitute the tropical or equatorial streams in England, have, during the present century, continually been gaining strength. As it is impossible that these "anti-trade" winds should alter their strength without a corresponding change of force in some portion of the trade-winds themselves, it would be interesting to discover in what part of the world this has especially been noticed. If the pressure of the trade-winds at different points of the Atlantic were regularly measured, it would be possible to give a direct answer to this question. The extreme seasons, of hot summers and mild winters, in England might even possibly be predicted by means of such measures, regularly kept, some days or fortnight, in advance. It is perfectly well known to those navigators who make the voyage from England to the West Indies that the north-east trades, of which they stand in need, are much more constant in some years than in others, and that to them succeeding years are more or less profitable according as the current of the trade-winds is regular and powerful, or the reverse. The investigation connected with the present diagram makes it highly probable that the secular increase of temperature, as well as the shorter intervals of change, common in the British climate are caused directly by these fluctuations of the trades.

To the Editor.

I am glad my paper coincided with your views of the cause of the secular variation in the temperature of the air at Greenwich being in the south-west winds; for the drift of air in different latitudes as well as in different years and seasons of the year is an inquiry that interests me very much at present in relation to Admiral FitzRoy's storm-signals and coast-warnings. I have completed the graphic representation of the progression of the seasons for the time occupied, from 1771 to 1863, by the Greenwich observations. The only general result which appears remarkable is the nearly secular variation in the length of winter and of summer compared with the very irregular times at which these seasons break up. It appears that when WINTER BREAKS UP EARLY, *summer breaks up late*, and *vice versâ*; also that when SUMMER *begins early*, WINTER *begins late*; but there seems to be no periodical rule of connexion between the beginnings of either of these

seasons and their ends except the rule before mentioned, that they *draw together by a slow secular contraction*, and *then open out again just as slowly*.

PLATE showing the Progression of the Seasons, at Greenwich, in Ninety-three Years.

The Plate represents, in a vertical direction, the years from 1771 to 1863 inclusive; and in a horizontal direction, the months from the 1st of January to the 31st of December, in figs. 1–3, and from the 1st of October to the 30th of September, in fig. 4. The dates of occurrence of the mean daily temperature of 40°, at the beginning and end of winter, in every year, and of 60° at the beginning and end of summer, are laid down in fig. 1. The curve-lines for these temperatures, respectively, are drawn through and near all the dates originally laid down upon the figure, giving equal weight to every date. In fig. 2, it is shown that the length of the interval between the first heat of summer and the first cold of winter reached two principal maxima (with one intervening minimum) during the period included in the Greenwich observations, namely, about the years 1780 and 1840, in the space of about sixty years. In fig. 3, the interval between the last cold of winter and the last heat of summer varies more rapidly. The Greenwich observations include two principal maxima and two principal minima for the length of this interval, both of them nearly forty years apart. In fig. 4, the duration of winter-cold and the duration of summer-heat are shown to vary in a nearly secular manner. The figure presents one maximum or one minimum only in the course of ninety-three years, and without any compensating minimum or maximum.

The dates of the daily mean temperatures of 40° and 60° (evaluated in the figures) are taken, by interpolation, from the "Monthly Mean Temperatures" of the air at Greenwich for ninety-three years.

Plate showing the Progression of the Seasons at Greenwich in Ninety-three Years. (For explanation, see p. 408.)

Fig. 1.

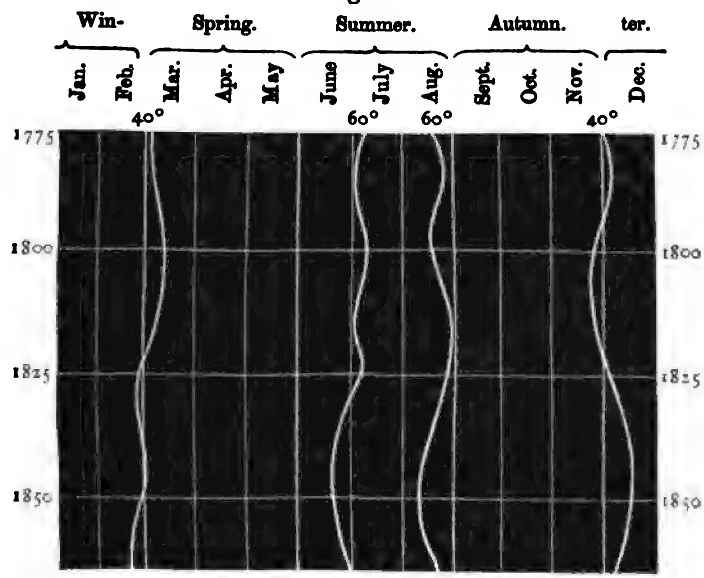


Fig. 2.

Summer and Autumn.

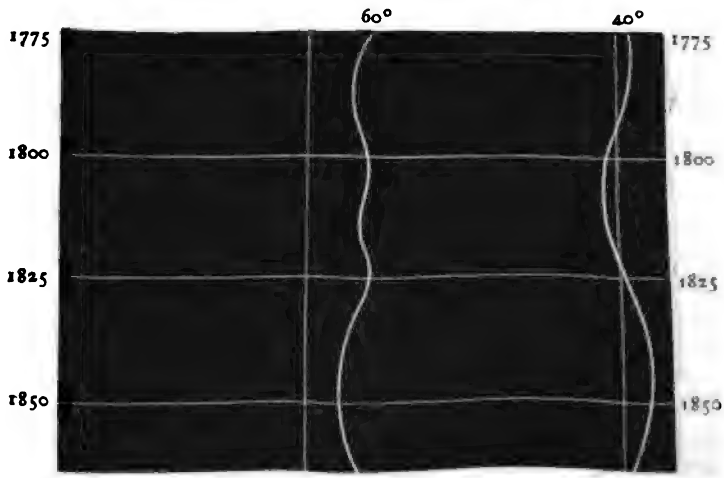


Plate showing the Progression of the Seasons at Greenwich in Ninety-three Years. (For explanation, see p. 408.)

Fig. 3.

Spring and Summer.

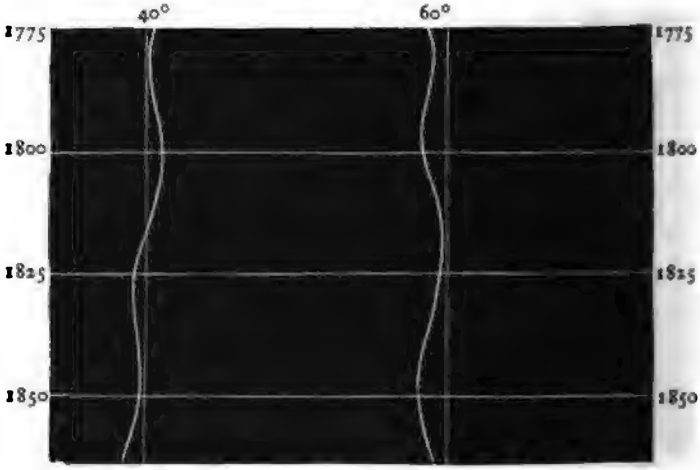
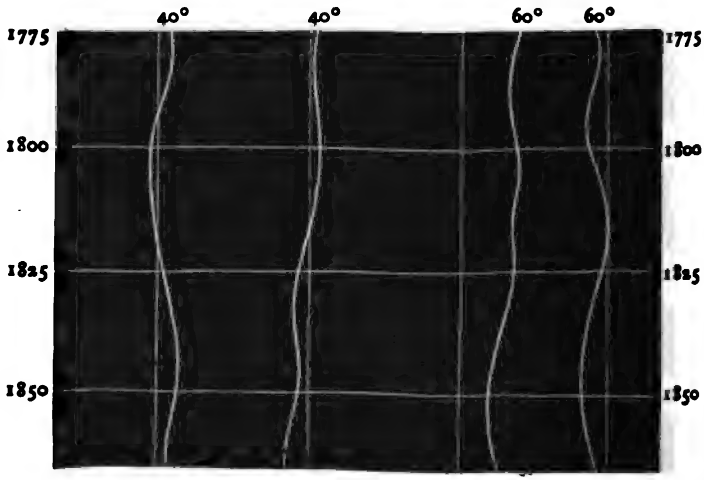


Fig. 4.

Winter. Summer.



XCV. *On Daily Weather Diagram for* 1864.

By C. O. F. Cator, Esq., M.A.

The object of this diagram is to bring together some of the more important meteorological elements, and to show in one view their daily variations and their corresponding relations with each other during the whole year; and it seems to me that for this purpose a diagram is far preferable to a table of figures. I have also added the imperial weekly average price of wheat, and the weekly mortality, to show how they may have been respectively influenced by the changes of the weather.

I propose, first, to consider each element separately, and then to compare its changes with those of every other element.

Part I.

1. *The Pressure of the Atmosphere.*—The general character of the readings of the barometer through the year may be divided into periods; first, a high period from January 1 to February 7 (38 days), then a low one, with one or two exceptions, till April 4 (57 days), then a long and generally steady period without any considerable fluctuations (except low, June 14) till August 9 (127 days), then very high for a week, then generally steady (with the exception of a rather sharp dip down from September 18 to 19, which was the wettest week of the year) till October 15 (67 days), after which there were considerable fluctuations to the end of the year (77 days),—there being three very low points reached, viz. on October 17, November 14 and 26, and one very high point on November 6, this last and November 14 being respectively the *maximum* and *minimum* in the year,—a circumstance worthy of note being that they were separated by 8 days only. On the whole, the reading of the barometer was high on 191 days, and on 175 days it was low. This would tend to show that the curve, when low, is more pointed, and when high more flat, than it is when high and low respectively. During the year the barometer rose sixty-six times, and fell seventy-one times; from this it would seem that it fell faster than it rose. Of all the months, January had the highest mean, and March the lowest. As regards the well-known and popular saying, that "the longer the time between the signs and the change foretold by them, the longer such altered weather will last, and, on the contrary, the less the time between a warning and a change, the shorter will be the continuance of such foretold weather," or "long foretold, long last; short notice,

soon past," it seems that there were two marked instances where this was true, viz. the long rise of the barometer, March 29 to April 8, after which was a very long and steady period of the barometer, and corresponding fine weather: again, the rise from September 16 to 25 preceded the long-lasting fine weather from September 24 to October 15, including the three or four days (October 1 to 4) when the wind blew very strong from the east. In other cases the former part of the saying, "long foretold, long last," does not seem to hold good; for as soon as the barometer has, after a long rise or fall, reached its *maximum* or *minimum*, it at once turns to fall or rise again with only a short continuance of changed weather; for instance, after the very long rise in the barometer from October 27 to November 6, it turned sharply down again, followed with much wind and rain to the end of the month. The most steady period was from July 4 to August 7, which corresponded nearly with the driest and hottest period of the year.

2. *The Temperature.*—This may also be divided into periods, in some cases being well marked, and showing very decided and sudden changes; after which the altered weather remained constant, and was not of short duration, as might have been expected from the above-mentioned popular maxim, "Long foretold, long last; short notice, soon past;" and in some cases after a long and gradual change of temperature, instead of a long-lasting changed temperature following, as might be expected, such changed temperature was only of short duration. This would tend to show to some extent that the maxim does not always (if it can ever be applied to temperature) hold, and in fact, in looking through the diagram, there seem to be very few cases in 1864 where it holds good as to temperature. The year came in with very cold weather, which lasted nine days, it being the coldest period of the year, and coinciding with the coldest period as deduced by Mr. Glaisher from forty-three years' observations; then by a very sudden and decided change (*i. e.* the mean temperature in two days increasing 14°) it became warm for the season, and continued generally so till February 3, *i. e.* twenty-five days; then, after a fall not so sudden (*i. e.* 10° in two days), a cold period of eight days till February 11, succeeded suddenly by five days of very warm weather of nearly uniform temperature, then cold till February 27, consisting of a rather quick decrease of 15° in three days, followed by a gradual rise of 16°·5 in eight days, which we may consider ended the winter; then the temperature remained generally, with one or two exceptions, about the average till April 3, succeeded by one

very warm day with a maximum of 62°, and then the most remarkable and sudden fall of the year, on April 5, viz. a fall in the maximum of 20°, and in the mean of 18°, which was one of the wettest days of the year: of this day more hereafter. After this remarkable change, the weather was very warm for forty-five days till May 20 (except a few days in the second week in May, which is in accordance with the general character of this particular period of the year, and with the dip of the curve of forty-three years, as shown by Mr. Glaisher, which is still a puzzle to most people), terminating with that very hot period, May 18 to 20, and reaching its climax May 18 to 20, then (simultaneously with heavy thunder-storms in the north) a sudden fall of temperature and nearly continuous cold weather for fourteen days, followed by a sudden rise, after which was a very steady period of thirty-four days to July 7, with the temperature near the average. This was a well-marked period, followed suddenly by two cold days, succeeded as suddenly by a great rise of temperature which lasted until August 8, constituting another well-marked period of thirty hot summer days. After which was a sudden fall of temperature, which continued to decrease till August 27, *i. e.* for nineteen days, the last ten of which were very cold for the season, with hoar-frost in many places. Hot weather then set in again until September 9; three of these days (September 7–9) were especially remarkable, the nights being warmer than any in the whole year. After this the temperature became step by step cooler to the end of the year in very decided periods, viz. September 10 to October 2 (twenty-three days), with a very uniform temperature of 57° or 58°, again very uniform from October 3 to 29 at about 52°·5, then fourteen cold days to November 12, with a gradually decreasing temperature, after which a rather sharp rise of 10° followed by a month of rather mild weather. The year ended with cold weather and sharp oscillations of temperature. One night (December 18) was very cold. The above-mentioned periods, with the dates of change, of duration in days, character of the change, whether sudden or otherwise, &c., are shown by Table I. Some of these periods are so well marked that one is almost disconnected from another, being in fact connected only by a single increasing or decreasing temperature,—the maximum of one day being the minimum of the next, and *vice versâ*.

It appears that, in December and January 1864, the days in London were a little less than half a degree warmer than at Greenwich; but that in every other month they were colder, the

difference increasing with the mean temperature from 0°·02 colder in February to 2°·8 colder in August, and then decreasing again with the decline of temperature to 0°·1 in November. The mean for the year was 1° lower, being colder by this amount.

The nights were in every month colder at Greenwich than in London, and a nearly uniform difference of 2½° prevailed throughout the year, except February, when the difference was only about half of that in the other months. This perhaps would be partly accounted for by the larger nocturnal amount of cloud in that month, and from the frequency of downfall,—rain or snow having been measured on 18 days, which is a greater number than in any other month, notwithstanding it is the shortest month in the year; and whenever it is raining, or snowing, or cloudy, the temperature is more uniform than when it is bright, and radiation is going on more rapidly.

That the daily range of temperature was greater in 1864 at Greenwich than in London in every month, the excess increasing from 1°·4 in February (the coldest month) to 5°·1 in August, which at Greenwich had the greatest daily range. It might have been expected that the difference of range would have increased with the range itself, which was generally the case, except in the winter months; for we find the difference was 1°·9 in December, 2°·3 in January, and then again 1°·4 in February, which would appear abnormal, and due to the cloudy nights before referred to as reducing terrestrial radiation in the country. The mean yearly difference of daily range was 3¼°.

The greater heat in the day, and greater cold at night, at Greenwich than in London, *i.e.* in the country than in the town, is probably due to the greater chance the air has to spread itself and become diffused quickly, whereas, in London or any town generally, the contiguity of the buildings prevents the free diffusion of one current of air with another. From the almost constant difference of 2½° in the night, it would seem that the fires in winter have very little to do with the greater warmth of the nights in the town than in the country; for, if they had, we should find the difference greater in winter than in summer.

The rain-fall in the year 1864, as is well known, was very deficient in this respect generally throughout England. There were only two really heavy daily falls, viz. April 5–6 and November 23–24, the respective amounts being 1·06 in. and 0·99 in.; moreover there were only four periods during the whole year which could be called wet, viz.—

March 8–12=10 days, in which the amount collected =2·2 in.
May 2–9 = 8 " " " " =1·4 in.
Sept. 13–18= 6 " " " " =1·9 in.*
Oct. 22–27= 6 " " " " =1·1 in.†

TABLE showing the Fall of Rain.

Months.	Amount in Inches.	Days on which any measurable amount of Rain fell.	Days on which 0·01 or upwards fell.
January	1·0	14	10
February	0·9	18	15
March	2·4	15	15
April	1·5	6	6
May	1·8	11	10
June	1·3	10	10
July	0·5	6	6
August	1·4	5	5
September	2·7	14	14
October	1·3	10	9
November	2·2	13	13
December	0·8	13	10
Totals	17·8	135	123

The fall of rain in 1864 was about 7 inches below the average.

TABLE showing the Numbers of Days on which the Wind blew from each Point at 9h A.M.

Months.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.
January	...	1	5	3	3	1	2	4	2	2	4	1	2	1	...	...
February	3	6	4	1	...	2	1	...	1	1	4	...	2	1	2	1
March	1	...	5	2	4	1	1	1	...	1	8	...	3	1	2	1
April	3	2	4	2	5	...	4	1	1	...	5	1	...	...	2	...
May	4	2	4	1	1	1	4	1	2	...	2	...	1	1	4	3
June	1	...	2	...	1	...	1	...	2	3	5	6	4	1	3	1
July	3	3	6	...	1	...	...	...	...	1	10	6	...	...	...	1
August	7	...	2	...	...	...	3	...	1	...	8	5	2	...	2	1
September	1	...	1	...	1	...	1	...	2	3	6	4	4	3	4	...
October	1	1	6	2	7	...	3	1	1	...	3	1	3	...	2	...
November	...	1	6	1	3	...	5	1	1	2	4	3	1	...	2	...
December	...	...	3	4	4	3	3	...	4	1	5	1	1	...	1	1
Totals	24	16	48	16	30	8	28	9	17	14	64	28	23	8	24	9

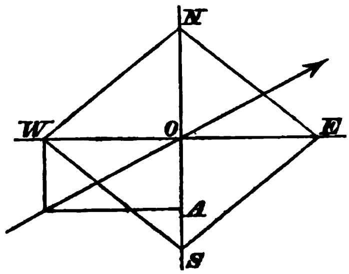
* Generally the wettest week of the year.
† The wettest in some parts of the country.

Or, condensing the above,

$$
\begin{aligned}
\text{N.} &= \text{N.} + \tfrac{1}{2}\,\text{N.N.E.} + \tfrac{1}{2}\,\text{N.N.W.} = 36\tfrac{1}{2} \\
\text{N.E.} &= \text{N.E.} + \tfrac{1}{2}\,\text{N.N.E.} + \tfrac{1}{2}\,\text{E.N.E.} = 64 \\
\text{E.} &= \text{E.} + \tfrac{1}{2}\,\text{E.N.E.} + \tfrac{1}{2}\,\text{E.S.E.} = 42 \\
\text{S.E.} &= \text{S.E.} + \tfrac{1}{2}\,\text{E.S.E.} + \tfrac{1}{2}\,\text{S.S.E.} = 36\tfrac{1}{2} \\
\text{S.} &= \text{S.} + \tfrac{1}{2}\,\text{S.S.E.} + \tfrac{1}{2}\,\text{S.S.W.} = 28\tfrac{1}{2} \\
\text{S.W.} &= \text{S.W.} + \tfrac{1}{2}\,\text{S.S.W.} + \tfrac{1}{2}\,\text{W.S.W.} = 85 \\
\text{W.} &= \text{W.} + \tfrac{1}{2}\,\text{W.S.W.} + \tfrac{1}{2}\,\text{W.N.W.} = 41 \\
\text{N.W.} &= \text{N.W.} + \tfrac{1}{2}\,\text{W.N.W.} + \tfrac{1}{2}\,\text{N.N.W} = \underline{32\tfrac{1}{2}} \\
& \qquad\qquad\qquad\qquad\qquad\qquad\quad 366
\end{aligned}
$$

Or, still further,

$$
\begin{aligned}
\text{N.} &= \text{N.} + \tfrac{1}{2}\,\text{N.E.} + \tfrac{1}{2}\,\text{N.W.} = 84\tfrac{3}{4} \\
\text{E.} &= \text{E.} + \tfrac{1}{2}\,\text{N.E.} + \tfrac{1}{2}\,\text{S.E.} = 92\tfrac{1}{4} \\
\text{S.} &= \text{S.} + \tfrac{1}{2}\,\text{S.E.} + \tfrac{1}{2}\,\text{S.W.} = 89\tfrac{1}{4} \\
\text{W.} &= \text{W.} + \tfrac{1}{2}\,\text{S.W.} + \tfrac{1}{2}\,\text{N.W.} = \underline{99\tfrac{3}{4}} \\
& \qquad\qquad\qquad\qquad\qquad 366
\end{aligned}
$$



$$\text{N O : E O : S O : W O} :: 84\tfrac{3}{4} : 92\tfrac{1}{4} : 89\tfrac{1}{4} : 99\tfrac{3}{4}.$$

Westerly over easterly winds .... $= 7\tfrac{1}{2} = \tfrac{15}{2}$

Southerly over northerly winds .... $= 4\tfrac{1}{2} = \tfrac{9}{2}$

Therefore, take O A : O W :: 9 : 15 or 3 : 5, and complete the parallelogram A W; the diagonal through O is the mean direction of the wind = about S.W. by W.

XCVI. *On Barometers with Scales of Inches and Millimètres.*
By L. Casella, Esq., M.B.M.S.

The attention of meteorologists having lately been directed to the graduation of barometers with double scales, of inches and millimètres, by Messrs. Packe, Mathews, and Tuckett, induced me as manufacturer to give the subject my careful consideration. To Mr. Packe for originating the inquiry, as well as to Messrs. Mathews and Tuckett for their close investigation of it, I feel much indebted; but as the matter so put forward by these gentlemen does not seem as yet to be clearly understood, I beg to state a few facts which may be useful to many observers.

1st. Barometers in brass frames, upon which a scale of inches and a scale of millimètres are engraved, should at 30 inches read also 761·75 millimètres. Then the index- or scale-error of the instrument for the scale of inches having been determined, that for the scale of millimètres can be easily calculated; for, the two scales having always the same temperature common to both, 1 inch is equal to 25·3916 millimètres.

2nd. It has hitherto been the general practice to make 30 inches correspond with 762 millimètres. Barometers so graduated are, speaking in a strictly scientific sense, incorrect in one of the scales. If an English standard measure has been used for laying off the inches, the millimètres are not accurate; but if a French standard measure has been employed, the millimètres will be correct, while the inches are slightly inaccurate. The blame for this want of precision should rather be given to the standard-scale makers than to the opticians, since the latter are in the habit of using measures made by the former, which it now appears are incorrect. Order either in France or England a standard brass scale of inches side by side with millimètres, and they make you 30 inches equal to 762 millimètres. The English maker will lay down true inches, the millimètres being incorrect; and it will be *vice versâ* with the French.

Doubtless both nations have been led into this error by the Conversion Tables, as given in Guyot's 'Meteorological and Physical Tables' and in many other works, forgetting that that table is for the purpose of converting lengths of the one scale into equivalents of the other at their respective standard temperatures only, viz. 62° Fahr. for inches, and 32° Fahr. for millimètres, on brass. Supposing the inches on such a barometer to be correct, the millimètres of the scale will be to true millimètres in the ratio

of 762 to 761·75; and supposing the millimètres correct, the inches of the scale will be to true inches as 30 is to 30·01.

3rd. Observers, by disregarding the temperature of the scales, frequently make mistakes in converting inches into millimètres. Some convert the reading of a barometer with a millimètre scale into inches by the table, before it is reduced to 0° centigrade by the French table for that purpose. The reduction should be made *before* the conversion. Thus, let the barometer read 772 at 4° centigrade. Here the reduction is 0·5 millimètre. Hence the reading at 0° centigrade would be 771·5, for which the Conversion Table gives 30·375 inches. Similarly to convert the indications of English barometers into the French values, each reading must be reduced to what it would be if the temperature of the mercury were 32° Fahr., and that of the brass 62° Fahr., by the tables for the purpose (such as Mr. Glaisher's), and then the equivalent value can be correctly got from the Conversion Table. Thus at a temperature of 40° Fahr., suppose

the barometer-reading to be	29·475 inches,
the reduction is	·030 inch;
so that the reduced reading is	29·445 inches,

for which the Conversion Table gives 747·89 millimètres.

XCVII. *On the Performance of a Watch Aneroid Barometer.* By G. J. Symons, Esq.

In the 'Proceedings' of this Society (vol. i. p. 380), Mr. C. V. Walker reported on the performance of a watch-aneroid. Having had one of the earliest which was made, and it having behaved as remarkably well as Mr. Walker's behaved ill, it seems to me only fair to give a brief statement of its performance, trials, &c. I hardly know when I was first supplied with it, but it was some time prior to September 1862, in which month I took it with me during a voyage to the Orkneys and other parts of the North of Scotland. Of course it had to bear the sea voyages, also a good deal of riding over roads of doubtful quality (on one occasion thirteen miles in a cart without springs; on another a saddle-girth gave way, when I and the aneroid got a violent jolt); and as I always wore it on geological and other rambles, it had no very quiet time. Prior to starting, I had adjusted it to show the true pressure (*i. e.* to read the same as the standard when reduced to 32°); during my stay in the North, I checked it against the

standards of the Rev. C. Clouston at Sandwick, of Mr. Iverach at Kirkwall, and the Board of Trade instruments at Aberdeen, in no case finding a difference exceeding 0·08 in.; on my return home it was within a hundredth of the truth.

During October 1862, I took it with me on a rain-gauge examining-tour in the midland counties: it behaved very well for some weeks; but on checking it against Mr. Ingram's standard at Belvoir Castle, I found it nearly a quarter of an inch wrong. I then remembered having one Sunday left it on my dressing-table at a friend's house: whether the adjusting screw was touched *then*, or whether it had caught against my waistcoat-pocket, I do not know; but, feeling sure that something had touched it, I left it with Messrs. Cooke, of York, to have a protecting plate put over the screw-head. Since that time (except once when I lent it to a friend) it has never varied more than a hundredth or two when tested against a standard. Considering that it has travelled fully 20,000 miles and has never cost another sixpence for repairs, am I not justified in speaking of it in the highest possible terms?

But let me turn to another branch of its good behaviour. It being of importance that the height of all the stations where rainfall observations are made should be ascertained as speedily as possible, and the bench-marks of the Ordnance Survey not being always readily found, I make it a rule constantly to observe the aneroid, when travelling by rail or otherwise; the result is a collection of lines of levels along most of the principal lines of rail, and many of the old turnpike-roads. Many of them are observations made when rushing along at express rate of forty, fifty, or even sixty miles an hour. The vibration of the train, perhaps also a vacuum or increased pressure caused by its sudden rush through the air, must render such observations useless; besides, there would not be time for the variation of level to act before one was a mile past the station. All very reasonable objections no doubt, but happily invalid, as I believe the following Tables and Diagram prove.

Of course my principal difficulty has been that the absolute sea-level pressure is seldom uniform over large tracts of country; this in Table II. has been partially overcome by choosing an intermediate station as the datum-line; but looking to the last column of both Tables, there seems little need to apologize for inequalities, the *worst* of which is but 0·13 in., and was probably an error of reading. It should be stated that the figures are copied directly from my note-book, and not corrected or adjusted in any way.

The extreme limits of error average 0·048 in Table I., and 0·047 in Table II. As the diameter of the instrument is 2 in., and it is graduated from 23 to 31, one hundredth of an inch is represented by 0·005; hence it is impossible to read closer, and flying along in the train often difficult to be sure of it. Under all these disadvantages the instrument must work remarkably well to yield such results. I may add that some of the observations in Table I. were made in stopping and some in through trains. I fancy there is a difference owing to rapid motion, but have unfortunately no means of knowing which are which, and the differences are so small that I am doubtful if it can be proved. If it is to be done, it must be by an aneroid, as no mercurial barometer could be read.

[All new watch-sized aneroids which have passed through my hands have acted as badly as that described by Mr. Walker, and referred to at the beginning of this paper. Very many watch-aneroids which have been made a little more than a year have acted as well as the one described by Mr. Symons, and yet not one that I have seen of this size has worked correctly. The test of correct working being the redetermination of the heights of places previously well determined, thus tested, no part of the scale has been found accurate, the inches being all laid down wrongly.

Take, for instance, the results of the Astronomer Royal's observations with one of the best of those instruments, in a walk up and down Shooter's Hill, occupying two hours, the aneroid returning exactly to its first state, and the differences at intermediate stations being found to be very trifling in going and returning.

	Mean of Height, going and coming.	Height by Ordnance Map.
Angerstein's Gate	− 15 feet	− 23 feet
Corner of Roman Road	− 3 "	+ 2 "
Charlton-end Lane	− 4 "	− 1 "
'Earl of Moira'	+ 36 "	+ 52 "
Eltham Road	+ 80 "	+ 93 "
Lane to Severndroog	+177 "	+201 "
Path into Wood	+222 "	+261 "

From these it would seem that the results given by this aneroid were too small by $\frac{1}{6}$ or $\frac{1}{7}$, and the scale of inches on the dial must have been erroneous; yet the instrument in its action was extremely delicate and beautiful.

After this another instrument was prepared, and the following are the results found by the Astronomer Royal.

At low elevations.

Aneroid.	Ordnance.	Aneroid.	Ordnance.
131 feet	156 feet	175 feet	203 feet
100 "	132 "	212 "	248 "
128 "	159 "	375 "	414 "
126 "	154 "	376 "	425 "

These agree precisely in character with those already mentioned.

At moderate elevation—Cut Bell Pass, in Cumberland, above Derwentwater.

Aneroid.	Barometer.
957 feet	948 feet

The error here is small, but it is the opposite way.

At greater elevations—Snoe Fell, in the Isle of Man.

Aneroid.	Sir Henry Somes's.
2140 feet	2080 feet.

The error here is very large, and it is clear that there is something wrong in the way of laying down inches on these instruments. Mr. Browning, of 111 Minories and 170 Strand, is now working upon this class of instruments, with the view of their greater perfection, and clearing them of this very serious error.]—Editor.

TABLE I. Observations on the Midland Line (Leicester and Peterborough Branch).

Stations.	Reading of Aneroid.								Reading above that at Leicester.								Excess. Mean.	Excess. Range.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Leicester ...	29·38	29·47	29·47	29·05	29·05	29·56	29·76	29·60										
Syston	·42	·49	·49	·10	·07	·62	·80	·65	+·04	+·02	+·05	+·05	+·02	+·06	+·04	+·05	=+·037	·04
Bearsley......	—	·48	·47	·10	·08	·66	·83	·64	—	+·01	·00	+·05	+·03	+·10	+·07	+·04	=+·043	·10
Brooksby ...	—	·46	·47	·09	·07	·62	·81	·64	—	−·01	·00	+·04	+·02	+·06	+·05	+·03	=+·027	·07
Frisby	·39	·45	·45	·08	·05	·58	·79	·62	+·01	−·02	−·02	+·03	·00	+·02	+·03	+·02	=+·009	·05
Ashfordby ...	·38	·43	·42	·05	·03	—	·77	·62	·00	−·04	−·05	·00	−·02	—	+·01	+·02	=−·011	·04
Melton	·36	·42	·41	29·03	29·01	·53	·78	·59	−·02	−·05	−·06	−·02	−·04	−·03	+·02	−·01	=−·026	·08
Owston	·05	29·07	29·07	28·70	28·70	—	—	—	−·33	−·40	−·40	−·35	−·35	—	—	—	=−·366	·07
Saxby	·30	—	—	—	—	·49	·72	·53	−·08	—	—	—	—	−·07	−·04	−·07	=−·065	·04
Whissendire	·28	—	—	—	—	·46	·68	·51	−·10	—	—	—	—	−·10	−·08	−·09	=−·092	·02
Ashwell	·24	—	—	—	—	·42	·63	·47	−·14	—	—	—	—	−·14	−·13	−·13	=−·135	·01
Oakham......	29·22	—	—	—	—	·40	·60	·46	−·16	—	—	—	—	−·16	−·16	−·14	=−·150	·02
Manton	—	—	—	—	—	·53	·72	·56	—	—	—	—	—	−·03	−·04	−·04	=−·037	·01
Luffenham...	—	—	—	—	—	·62	·80	·66	—	—	—	—	—	+·06	+·04	+·06	=+·053	·02
Morcot	—	—	—	—	—	29·56	29·80	29·62	—	—	—	—	—	·00	+·04	+·02	=+·020	·04

TABLE II. Observations on the South-Eastern Main Line and Reading Branch.

Stations.	Reading of Aneroid.				Reading above that at Reigate.				Excess.	
									Mean.	Range.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
London Bridge	30·19	30·24	29·60	29·54	+·27	+·24	+·24	+·26	+·252	·03
New Cross	·21	....	....	....	·29	....	....	....	·290	
Forest Hill	·08	....	·50	....	·16	....	+·14	....	·150	·02
Sydenham	·08	....	·50	....	·16	....	+·14	....	·150	·02
Penge	·06	....	....	....	·14	....	....	....	·140	
Anerley	·05	....	·50	....	·13	....	+·14	....	·135	·01
Norwood	·04	....	....	....	·12	....	....	....	·120	
Croydon	30·04	30·10	·48	·37	·12	+·10	+·12	+·09	·108	·03
Caterham	29·97	....	·40	....	+·05	....	+·04	....	+·045	·01
Merstham	·92	29·97	·34	·26	·00	—·03	—·02	—·02	—·018	·03
Redhill	·94	30·00	·40	·32	+·02	·00	+·04	+·04	+·025	·04
Reigate	·92	·00	·36	·28	Datum	level.				
Betchworth	29·95	·03	·39	·33	+·03	+·03	+·03	+·05	+·035	·02
Boxhill	30·04	·10	·50	·44	·12	+·10	+·14	+·16	+·130	·06
Dorking	30·03	30·09	·46	·38	+·11	+·09	+·10	+·10	+·100	·02
Gomshall	29·91	29·96	·37	·28	—·01	—·04	+·01	·00	—·010	·05
Chilworth	30·07	....	·50	·44	+·15	....	+·14	+·16	+·150	·02
Shalford	·12	30·17	·57	·48	·20	+·17	+·21	+·20	·195	·04
Guildford	30·08	·16	·57	·47	·16	+·16	+·21	+·19	·180	·05
Ash	29·96	....	....	·37	·04	....	....	+·09	·065	·05
Aldershott	·90	·06	·45	·39	—·02	+·06	+·09	+·11	·060	·13
Farnboro'	....	....	·45	·38	....	....	+·09	+·10	·095	·01
Blackwater	30·10	30·10	29·48	29·42	+·18	+·10	+·12	+·14	·135	·08

XCVIII. *Date of Rainfall, and Close of Rain-Month.*

To the Editor of the 'Proceedings of the Brit. Meteor. Soc.'

DEAR SIR,—Your astonishment at my error on this point is equalled by my own at being in error. If the practice of the observers of the British Meteorological Society is identical with that of their Scottish brethren, a material advance towards uniformity exists, and, as I said in the pamphlet, "uniformity is of more consequence than strict accuracy;" so I will immediately adopt and recommend whichever is really the practice of the majority.

You will doubtless allow me to explain why I said that the British Meteorological Society would enter a fall ending at 11 P.M. on January 17th, on the 18th. The head-line of the Society's observation-form runs thus:—

"At —— A.M. local time, rain fallen in previous twenty-four hours;" that is to say, enter each morning how much has fallen since the previous morning. How can this instruct us to, how can my fellow-observers, enter a fall between the afternoon and 11 P.M. on the 17th, on the 17th? Clearly it fell in the twenty-four hours previous to —— A.M. on the 18th, not the 17th. If the A.M. were absent, there might be doubt; but, as it is, I can come to no conclusion but that a fall occurring on the evening of the one day would be in the twenty-four hours previous to —— A.M. on the next. This view is confirmed by the note, as to maximum and minimum temperatures, on the back of the same form.

It is important that no hasty decision be come to upon this matter, since it involves also the far more important point of the date of closing the monthly and annual rain-record. Theoretically this should be midnight; but you truthfully remark, "This cannot be followed out generally." We must take things as we find them, and be guided by the general practice. Steps will shortly be taken to ascertain the hour at which each observer closes his or her return, and when the whole (about 1100) have been classified I will communicate the result to you.

I wish this note to be as short as possible, but would just remark that the practice of entering a fall on the date of measurement is adopted both by Admiral FitzRoy in his daily 'Meteorological Reports' (where he gives "Rainfall since last Report") and by Col. Sir H. James, R.E., in his 'Instructions for taking Meteorological Observations,' Tables, p. 34, "Total quantity of rain on ground for the twenty-four hours previous to 9.30 A.M."

Leaving for the moment the British Meteorological Society out of the question, we have on one side the Scottish Meteorological Society, on the other Admiral FitzRoy and Col. Sir H. James.

Yours very truly,

G. J. SYMONS.

SUNDRY NOTES.

On Scientific Experiments in Balloons.

By JAMES GLAISHER, Esq., F.R.S. &c.

From the 'Proceedings of the Royal Institution of Great Britain.'

MR. GLAISHER, at the beginning, referred to the discourse given by him two years since, when he had made eight ascents, for the purpose of scientific researches, in the higher regions of the atmosphere, and said since that time he had made seventeen additional. He described the process of filling a large balloon, and briefly described a balloon ascent, speaking of the novel sensation at first experienced; of the extreme coldness and dryness of the air at great elevations; of the painless death awaiting the aërial traveller who should ascend to an elevation too great for his power of endurance, and compared it to that of the mountain traveller, who, benumbed and insensible to suffering, yields to the lethargy of approaching sleep, and reposes to wake no more. Moral energy in both cases, he stated, was the only means of safety.

He then exhibited the several instruments used, pointing out their extreme sensitiveness and delicacy, and then spoke of the primary objects of balloon research.

Subjects of Research by means of Balloons.

1st. To determine the rate of decrease of temperature, with increase of elevation; and to ascertain whether the results obtained by observations on mountain sides—viz. a lowering of temperature of 1° for every increase of elevation of 300 feet—be true or not.

2nd. To determine the distribution of the water, in the invisible shape of vapour, in the air below the clouds, in the clouds, and above them, at different elevations.

3rd. To compare the results, as found by different instruments, together:—

1. The temperature of the Dew-point, as found by—
   - Dry and Wet Thermometers—(Free).
   - Dry and Wet Thermometers—(Aspirated, or air made to pass rapidly).
   - Daniell's Dew-point.
   - Regnault's Dew-point—(Blowing).
   - Regnault's Dew-point—(Air made to pass rapidly).
2. To compare the readings of—
   - Mercurial and Aneroid Barometers, &c.

4th. Solar radiation, by taking readings of the blackened-bulb thermometer fully exposed to the sun, with simultaneous observations of the dry-bulb thermometers, and also of observations of Herschel's actinometer.

5th. To determine whether the solar spectrum, when viewed from the earth, and far above it, exhibited any difference; whether there were a greater or less number of dark lines crossing it, particularly when near sun-setting.

6th. To determine whether the horizontal intensity of the earth's magnetism was less or greater with elevation.

Propagation of sound.
Amount of ozone, &c.

In every ascent a second or third thermometer, differently graduated, has been used to check the accuracy of the readings of the dry thermometer, and the truthfulness of the temperature shown by it. In some of the ascents a delicate blackened-bulb thermometer was placed near to the place of the dry-bulb thermometer, fully exposed to the sun in cloudless skies, or to the sky at all times: the readings of this instrument were nearly identical with those of the dry-bulb thermometer in clouded states of the sky, and thus acted as an additional check.

At all times one or the other, or both Regnault's and Daniell's hygrometers, have been used sufficiently often at all heights to show whether the wet-bulb thermometer was in proper action, and to check the results given by the use of the dry- and wet-bulb thermometer on the reduction of the observations.

The author said he would not give a detailed account of the experiments in the year 1862 and 1863, as they were published, but would confine himself to some of the results.

He said it was soon found that the state of the sky exercised a great influence, and the experiments had to be repeated with two groups, one with cloudy skies and the other with clear skies.

The results are as follows:—

The Decline of the Temperature of the Air, with Elevation, when the Sky was cloudy.

	feet.		feet.		°						feet.
From	0	to	1,000	was	4·5	from	17	experiments,	or 1°	in	223
„	1,000	„	2,000	„	3·6	„	21	„	„		278
„	2,000	„	3,000	„	3·7	„	22	„	„		271
„	3,000	„	4,000	„	3·4	„	20	„	„		295
„	4,000	„	5,000	„	3·3	„	13	„	„		333
„	5,000	„	6,000	„	3·2	„	7	„	„		313
„	6,000	„	7,000	„	2·7	„	5	„	„		371
„	7,000	„	8,000	„	2·4	„	4	„	„		417
„	8,000	„	9,000	„	2·2	„	4	„	„		455
„	9,000	„	10,000	„	2·2	„	4	„	„		455
„	10,000	„	11,000	„	2·2	„	4	„	„		455
„	11,000	„	12,000	„	2·2	„	4	„	„		455
„	12,000	„	13,000	„	2·2	„	4	„	„		455
„	13,000	„	14,000	„	2·3	„	4	„	„		435
„	14,000	„	15,000	„	2·0	„	4	„	„		500
„	15,000	„	16,000	„	2·1	„	4	„	„		477
„	16,000	„	17,000	„	1·2	„	2	„	„		833

	feet.		feet.		°					feet.
From	17,000	to	18,000	was	1·3	from	2	experiments,	or 1° in	771
„	18,000	„	19,000	„	1·4	„	2	„	„	715
„	19,000	„	20,000	„	0·9	„	2	„	„	909
„	20,000	„	21,000	„	1·1	„	2	„	„	911
„	21,000	„	22,000	„	0·8	„	2	„	„	1,250
„	22,000	„	23,000	„	0·8	„	2	„	„	1,250

These results show, when the sky is cloudy, the decline of temperature at every 1000 feet increase of elevation. Up to 5000 feet the number of experiments upon which each result is based varies from 13 to 22; at 6000 and 7000 feet to 7 and 5 respectively; from 7000 to 16,000 feet to 4; these having been made on two days, viz. 1863, June 26 and September 29, on which days the balloon was frequently enveloped in fog and clouds to the height of three and four miles, and those above 16,000 feet on the former of these two days only, during the ascent and descent, the sky being still covered with cloud when the balloon was between four and five miles high.

The Decline of the Temperature of the Air, with Elevation, when the Sky was clear, or chiefly clear.

	feet.		feet.		°					feet.
From	0	to	1,000	was	6·2	from	9	experiments,	or 1° in	162
„	1,000	„	2,000	„	4·7	„	9	„	„	213
„	2,000	„	3,000	„	3·8	„	11	„	„	264
„	3,000	„	4,000	„	3·3	„	12	„	„	304
„	4,000	„	5,000	„	2·9	„	12	„	„	345
„	5,000	„	6,000	„	2·6	„	17	„	„	385
„	6,000	„	7,000	„	2·5	„	15	„	„	401
„	7,000	„	8,000	„	2·7	„	12	„	„	371
„	8,000	„	9,000	„	2·5	„	12	„	„	400
„	9,000	„	10,000	„	2·4	„	12	„	„	417
„	10,000	„	11,000	„	2·6	„	13	„	„	385
„	11,000	„	12,000	„	2·3	„	11	„	„	435
„	12,000	„	13,000	„	2·2	„	11	„	„	455
„	13,000	„	14,000	„	2·0	„	11	„	„	500
„	14,000	„	15,000	„	1·7	„	9	„	„	588
„	15,000	„	16,000	„	2·2	„	9	„	„	455
„	16,000	„	17,000	„	1·9	„	7	„	„	526
„	17,000	„	18,000	„	1·7	„	7	„	„	588
„	18,000	„	19,000	„	1·5	„	7	„	„	665
„	19,000	„	20,000	„	1·3	„	7	„	„	771
„	20,000	„	21,000	„	1·2	„	7	„	„	833
„	21,000	„	22,000	„	1·1	„	7	„	„	911
„	22,000	„	23,000	„	1·0	„	4	„	„	1,000
„	23,000	„	24,000	„	1·3	„	2	„	„	771
„	24,000	„	25,000	„	1·1	„	2	„	„	909
„	25,000	„	26,000	„	1·0	„	1	„	„	1,000
„	26,000	„	27,000	„	1·0	„	1	„	„	1,000
„	27,000	„	28,000	„	0·9	„	1	„	„	1,111
„	28,000	„	29,000	„	0·8	„	1	„	„	1,250

Up to the height of 22,000 feet, the number of experiments varies from 7 to 17; and there can be but little doubt that the number showing the decrease of temperature is very nearly true, and approximates closely to the general law. Above 24,000 feet the number of experiments is too few to speak confidently upon them, but they are in accordance with the series deduced from the experiments at less elevations.

A decline of temperature under a clear sky of 1° takes place within 100 feet of the earth, and at heights exceeding 25,000 feet it is necessary to pass through 1000 feet of vertical height, as appears in the last column of the preceding Table, for a decline of 1° of temperature.

By adding together successively the decline of temperature for each 1000 feet, the whole decrease of temperature from the earth to the different elevations is found; the results, with a cloudy sky, are as follows:—

When the Sky was cloudy.

	feet.		feet.		°			feet.
From	0	to	1,000	the decrease was	4·5,	or 1° on	the average of	223
,,	0	,,	2,000	,,	8·1	,,	,,	247
,,	0	,,	3,000	,,	11·8	,,	,,	255
,,	0	,,	4,000	,,	15·2	,,	,,	263
,,	0	,,	5,000	,,	18·5	,,	,,	271
,,	0	,,	6,000	,,	21·7	,,	,,	277
,,	0	,,	7,000	,,	24·4	,,	,,	287
,,	0	,,	8,000	,,	26·8	,,	,,	299
,,	0	,,	9,000	,,	29·0	,,	,,	311
,,	0	,,	10,000	,,	31·0	,,	,,	321
,,	0	,,	11,000	,,	33·0	,,	,,	329
,,	0	,,	12,000	,,	35·6	,,	,,	337
,,	0	,,	13,000	,,	37·8	,,	,,	344
,,	0	,,	14,000	,,	40·1	,,	,,	349
,,	0	,,	15,000	,,	42·1	,,	,,	356
,,	0	,,	16,000	,,	44·2	,,	,,	362
,,	0	,,	17,000	,,	45·4	,,	,,	375
,,	0	,,	18,000	,,	46·7	,,	,,	386
,,	0	,,	19,000	,,	48·1	,,	,,	395
,,	0	,,	20,000	,,	49·0	,,	,,	409
,,	0	,,	21,000	,,	50·1	,,	,,	419
,,	0	,,	22,000	,,	50·9	,,	,,	432
,,	0	,,	23,000	,,	51·7	,,	,,	445

These results, showing the whole decrease of temperature of the air from the earth up to 23,000 feet, differ very considerably from those with a clear sky, to be spoken of presently. The numbers in the last column show the average increment of height for a decline of 1°, as found by using the temperature of the extremities of the column alone. To 1000 feet high the average is 1° in 223 feet, increasing gradually to 1° in 445 feet at 23,000 feet.

When the Sky was clear, or chiefly clear.

	feet.		feet.		°			feet.
From	0	to	1,000	the decrease was	6·2,	or 1° on	the average	of 162
„	0	„	2,000	„	10·9	„	„	184
„	0	„	3,000	„	14·7	„	„	204
„	0	„	4,000	„	18·0	„	„	223
„	0	„	5,000	„	20·9	„	„	239
„	0	„	6,000	„	23·5	„	„	256
„	0	„	7,000	„	26·0	„	„	271
„	0	„	8,000	„	28·7	„	„	279
„	0	„	9,000	„	31·2	„	„	289
„	0	„	10,000	„	33·6	„	„	298
„	0	„	11,000	„	35·6	„	„	309
„	0	„	12,000	„	37·9	„	„	317
„	0	„	13,000	„	40·1	„	„	324
„	0	„	14,000	„	42·1	„	„	333
„	0	„	15,000	„	43·8	„	„	343
„	0	„	16,000	„	46·0	„	„	348
„	0	„	17,000	„	47·9	„	„	355
„	0	„	18,000	„	49·6	„	„	363
„	0	„	19,000	„	51·1	„	„	372
„	0	„	20,000	„	52·4	„	„	382
„	0	„	21,000	„	53·6	„	„	392
„	0	„	22,000	„	54·7	„	„	405
„	0	„	23,000	„	55·7	„	„	413
„	0	„	24,000	„	57·0	„	„	422
„	0	„	25,000	„	58·1	„	„	431
„	0	„	26,000	„	59·1	„	„	441
„	0	„	27,000	„	60·1	„	„	449
„	0	„	28,000	„	61·0	„	„	459
„	0	„	29,000	„	61·8	„	„	469
„	0	„	30,000	„	62·3	„	„	482

These results, showing the whole decrease of temperature from the ground to 30,000 feet, differ greatly, as just mentioned, from those with a cloudy sky.

The numbers in the last column, showing the average increase of height for a decline of 1° of temperature from the ground, to that elevation, are all smaller than those with a cloudy sky at the same elevation. Each result is based upon at least seven experiments, taken at different times of the year, and up to this height considerable confidence may be placed in the results; they show that a change takes place in the first 1000 feet of 1° on an average in 162 feet, increasing to about 300 at 10,000 feet. In the year 1862, this space of 300 feet was at 14,000 feet high, and in 1863 at 12,000 feet. Therefore, the change of temperature has been less in 1863 than in 1862, and less in 1864 than in 1863; but the experiments have all been taken at different times of the year.

Without exception, the fall of 1° has always taken place in the smallest space when near the earth.

Treating the observations for determining the degrees of humidity of the air in the same way, the following are the results:—

When the sky was cloudy, saturation being considered as 100, the degree of humidity on the earth was	74	from	19	experiments.
At 1,000 feet	76	„	33	„
„ 2,000 „	76	„	34	„
„ 3,000 „	78	„	35	„
„ 4,000 „	75	„	27	„
„ 5,000 „	74	„	16	„
„ 6,000 „	73	„	14	„
„ 7,000 „	62	„	11	„
„ 8,000 „	54	„	11	„
„ 9,000 „	50	„	11	„
„ 10,000 „	48	„	10	„
„ 11,000 „	47	„	10	„
„ 12,000 „	52	„	6	„
„ 13,000 „	58	„	6	„
„ 14,000 „	52	„	5	„
„ 15,000 „	59	„	3	„
„ 16,000 „	59	„	2	„
„ 17,000 „	47	„	2	„
„ 18,000 „	33	„	2	„
„ 19,000 „	24	„	2	„
„ 20,000 „	29	„	2	„
„ 21,000 „	22	„	2	„
„ 22,000 „	34	„	1	„
„ 23,000 „	40	„	1	„

The law of moisture here shown is a slight increase from the earth to the height of 3000 feet, and then a slight decrease to 6000 feet, the degree of humidity being at this elevation nearly of the same value as on the ground; from 6000 to 7000 feet, there is a large decrease, and then an almost uniform decrease to 11,000 feet; it increases from 12,000 to 16,000 feet, and then decreases; the number of experiments up to 11,000 feet vary from 10 to 33; and I think good confidence may be placed in the result to this elevation, but at heights of 12,000 feet the number of experiments are evidently too small to speak with any confidence in respect to the results.

By treating the results with a clear or a nearly clear sky in the same way, the following results were obtained:—

With a clear sky the degree of humidity on the ground was	59	from	9	experiments.
At 1,000 feet	61	„	14	„
„ 2,000 „	70	„	17	„
„ 3,000 „	71	„	23	„
„ 4,000 „	71	„	19	„
„ 5,000 „	69	„	17	„
„ 6,000 „	62	„	15	„
„ 7,000 „	56	„	16	„

At 8,000 feet	....	50	from	14	experiments.
„ 9,000 „	....	50	„	9	„
„ 10,000 „	....	46	„	18	„
„ 11,000 „	....	43	„	10	„
„ 12,000 „	....	35	„	8	„
„ 13,000 „	....	37	„	7	„
„ 14,000 „	....	37	„	7	„
„ 15,000 „	....	44	„	5	„
„ 16,000 „	....	40	„	5	„
„ 17,000 „	....	39	„	4	„
„ 18,000 „	....	21	„	2	„
„ 19,000 „	....	36	„	2	„
„ 20,000 „	....	33	„	1	„
„ 21,000 „	....	32	„	1	„
„ 22,000 „	....	21	„	1	„
„ 23,000 „	....	16	„	1	„

The law of moisture here shown is a slight increase to 1000 feet, a considerable increase between 1000 feet and 2000 feet; a nearly constant degree of humidity from 2000 to 5000 feet, and a gradual decrease afterwards to 12,000 feet. At greater heights, the numbers are less regular. The results up to 11,000 feet are based upon experiments varying from 10 to 23, and are most likely very nearly true normal values; at heights exceeding 12,000 feet, the number of experiments have varied from 1 to 8, and no general confidence can be placed in them.

By comparing the results from the two states of the sky, the degree of humidity of the air up to 1000 feet high is 15 less with a clear sky than with a cloudy; from 2000 to 5000 is from 4 to 6 less; at 6000 feet the air with a clear sky is much drier than at 5000 feet, but with a cloudy sky it is nearly of the same degree of humidity, so that the difference between the two states is large, amounting to no less than 11; the difference decreases to 0 at 9000 feet, but increases to 4 at 11,000 feet; at heights exceeding 11,000 feet, the air with clear skies generally becomes very dry, but with cloudy skies frequently becomes more humid, as was to be expected from the fact of the presence of clouds at heights exceeding three and four miles.

In both states of the sky at extreme elevations, the air becomes very dry, but, so far as my experiments go, is never free from water.

At the end of the year 1863 the results for temperature were laid down on a diagram, and the resulting curve was a hyperbola; continuing this curve upwards, and reading out the decrease of elevation, the following were the results:—that at the height of

50,000 ft.	the decline of temperature from the earth would be					83°
100,000 „	or 19 miles		„	„	„	97
200,000 „	38	„	„	„	„	106
538,000 „	100	„	„	„	„	112¾
1,056,000 „	200	„	„	„	„	115½

Showing that large changes take place near the earth, amounting to 24° in the first mile, becoming less and less the further removed, till the change from 100 miles to 200 miles is less than 3°.

As these results were deduced chiefly from experiments in the summer and during the hours of the day, it became desirable to take experiments at other times in the year, to ascertain whether this law would hold good at all times of the year, and at all times of the day.

For this purpose it was necessary to take experiments in the winter, spring, and autumn. He then described the experiments made at these seasons, and pointed out that those made on September 29, January 12, and April 6, during the day, differed very much from the general laws; and those on June 13, 20, and 27, made a little before, at the time of sunset, and a little afterwards, differed materially from those made when the sun was at a good altitude; for instance, on June 13, at the time of sunset, no difference in temperature was experienced for 2000 feet from the earth.

It is very clear from the particulars of each ascent, that they cannot all be combined, or all used in deducing general laws. Those ascents which have been made during the past year under similar circumstances to those from which the laws of decrease of temperature were found, when combined, do not change the values previously found to any great amount; but those which have been made under other circumstances, such as in the winter and at times of the setting sun, differ very greatly indeed.

The deviation from this law, however, in winter is certainly of the highest importance to us; the meeting of a strong current of air from the S.W. of so great a depth as nearly one mile, over our country on January 12, in the season of winter, which current I know continued many days, must have exercised great influence. This was the first instance of meeting with a stream of air of higher temperature than on the earth; above this the air was dry, and higher still it was very dry: fine granular snow was falling thickly above this warm stream of air.

The S.W. current being thus observed is of the highest importance as bearing upon the very high mean temperature we experience during winter, so much higher than is due to our position on the earth's surface, and it is highly probable that to its fluctuations the variations of our winters are due.

Our high winter temperature has hitherto been referred for the most part to the influence of the heated water of the Gulf Stream; but, if this were the case, the same agency being at work around the coast of France should exercise the same influence, yet we know that the winters of France are more severe than our own, though situated so much south of us.

Dr. Stark, of Edinburgh, some years since referred the mildness of the winters in Britain for the most part to prevalence of the S.W. or anti-trade wind, which is the prevailing aërial current in this latitude during winter.

He observes, so long as these winds blow, we have no frosts or intense colds; but the moment the wind changes during winter to an easterly, north-easterly, or northerly direction, we have both frost and snow, and more or less intense cold.

The S.W. winds in their course meet with no obstruction in coming to us, but they blow directly to us and to Norway over the Atlantic; and hence we enjoy a much milder climate during winter than any other lands not similarly situated with regard to such winds.

The south-west winds cannot reach France till they have crossed the whole of Spain and the high mountain-range of the Pyrenees; and by the time they have crossed that mountainous country they are so much cooled that France can derive comparatively little benefit from them, and hence apparently her more severe winters.

Another fact may be inferred from this winter trip: it has always been a matter of great difficulty to me to account for the simultaneous appearance of dense fog over the whole country and extending far out to sea; but the fact of a warm current of air, situated under a mass of snow falling, would fully account for the production of any amount of fog.

Another inference may be drawn from the facts noticed. If during the prevalence of a warm current of air passing over these islands there can be currents of air of so low a temperature as experienced, it is evident that as it is but a struggle between two or more forces, either of which may preponderate at any moment, it is not safe, therefore, in the winter months, how mild soever the weather may be, to go thinly clothed at any time; for at any moment this warm current may be deflected, and its place occupied by the cold current, and thus some of our sudden and apparently unaccountable changes may be due.

From the fact of no change of temperature being met with at the time of sunset on June 13, for 2000 feet from the earth, that a much smaller change took place than usual on June 20, a little before sunset, and that on June 27, after sunset, as well as could be determined, the change to 3000 feet was small, it would seem that the *laws which hold good by day do not hold good by night; indeed, it seems probable that at night, for some little distance, the temperature may increase with elevation, instead of decreasing.* This can only be determined by experiments at night.

Comparing the results of one experiment with another with respect to the moisture in the air, at the same elevation, it is found to be very different at different times; and that on the same day the moisture is very differently distributed, there having been on some of the days of experiments several successive wet and dry strata placed one above the other.

The variation in this climate, its frequent disturbed atmosphere, the smallness of the country, causing great anxiety after passing through clouds and out of sight of the earth, for fear of descending over the sea, when the balloon has no longer power to keep up, rendering each experiment limited in its duration, show that per-

haps this country is not the best for determining the laws which govern atmospheric changes.

Mr. Glaisher said he was glad to learn that similar observations are contemplated being made in France, and he hoped that similar observations will be made in other countries; for it is probable that above the large plains of the Continent, where the weather is more uniform, and where an observer can be for hours out of sight of land without anxiety, that the experiments can be more easily made, and probably, too, the general laws made more easily apparent.

Many ascents will, however, be necessary; clouds as large, and clouds far colder than any I have met with, were experienced by Messrs. Bixio and Barral, in their ascents, in June and July 1850, from Paris. These gentlemen made two ascents for scientific purposes, and although from accidents the ascents were of short duration, the results were of high interest. Among them, they noticed that they passed through a cloud of icicles, which sustained themselves in the air, as it appeared to them, contrary to the laws of gravity; but upon their horizontal surfaces they saw beneath them, however, an exact image of the sun, formed by the reflexion of the luminous rays on the crystals of ice floating about in a foggy atmosphere; and they noticed the temperature of the cloud to be as low as −40°, a far greater degree of cold than I ever experienced.

With such variations as these, as many ascents will be necessary to be made in France as in England, to determine general laws; but each ascent may be made far richer in results than any one in England. In France, the duration of a journey will be limited only by the wishes of the observer, and not as here by the sea, or by one solitary hour's observations—that being the time frequently in which we approach the sea.

It is certain that there are in the higher regions of the earth's atmosphere spaces subjected to great cold, and others to considerable heat; that there exist some clouds of very low temperature, and some, as those passed through on January 12, for a mile in thickness, of comparatively high temperature.

The presence of such, either cold or hot currents, passing over the country must play an important part in all our meteorological phenomena, and must exert a great influence upon our climate.

When these experiments were first undertaken, it was expected that a few ascents would have given the information sought; the number of experiments made is twenty-five, and, so far from exhausting the subject, they indicate a much wider field for future operations.

The law of decrease of temperature under ordinary circumstances, both with a clear and a cloudy sky, when the sun is above the horizon, in the months of summer, I think is pretty well determined; but from the series of observations made in winter, we cannot say such laws hold good throughout the year: neither can we say that the laws which hold good by day will be true by night; and the general result of these differences must be that the theoretical law of refraction now

used must be abandoned, and that every observatory will have to determine its own laws independently.

Solar Radiation: Blackened-bulb Thermometer, and Herschel's Actinometer Observations.

On August 31, at the heights of 7000 and 8000 feet, the blackened-bulb thermometer, exposed to the full influence of the sun, read 3° only higher than the shaded thermometer.

On September 29, at the height of 14,000 feet, the excess of reading of the blackened-bulb thermometer was 2½° only under a bright sun, the increase of readings of the actinometer was from 3 to 5 divisions only; at 13,000 feet the excess of the blackened-bulb readings increased to 4° and 5°, and the increase in one minute of the actinometer-readings was 7 to 8 divisions. At the height of 3000 feet and 4000 feet the influence of the sun increased, raising the blackened-bulb to 7° and 8° in excess of the readings of the shaded thermometer; the scale-readings of the actinometer increased to 20 and 25 divisions in one minute, and on reaching the ground the increase in the same time was from 45 to 50 divisions.

On January 12 the readings of the exposed and shaded thermometers were nearly alike.

On April 6 I was unable to use the actinometer, and never succeeded in placing it properly. The excess of reading of the blackened-bulb thermometer was but small during the cloudy state of the sky, and increased to 5° and 6° at 10,000 feet; this excess increased on descending into the lower atmosphere, until cloud was entered.

On June 13 the excess was at all times small.

On June 22, at many inspections the readings of the two thermometers were identical.

On June 27, the exposed thermometers nearly always read lower than the shaded thermometer; on examination of these instruments afterwards, they were both found to read correctly.

On August 29, the blackened-bulb thermometer read lower than the shaded thermometer till 6000 feet were passed; it then read higher, increasing to 7° at 14,000 feet high.

From all these experiments it seems that the heat-rays in their passage from the sun pass the small bulb of a thermometer, communicating very little or no heat to it, similar results being shown by the use of Herschel's actinometer on every occasion that I have had an opportunity of using it. *From these experiments we may infer that the heat-rays from the sun pass through space without loss, and become effective only where wanted, and in proportion to the density of the atmosphere or the amount of water present through which they pass; and, if so, the proportion of heat received at Mercury, Venus, Jupiter, and Saturn may be the same as that received at the Earth, if the constituents of their atmospheres be the same as that of the Earth, and greater if the density be greater; so that the effective solar heat at Jupiter and Saturn may be greater than at either the inferior planets Mercury or Venus, notwithstanding their far greater distances from the sun.*

Different Velocities of Air.—The Wind.

On September 29, the balloon left Wolverhampton at 7^h 43^m A.M., and fell near Sleaford, a place ninety-five miles from the place of ascent, at 10^h 30^m A.M. During this time the horizontal movement of air was thirty-three miles, as registered at Wrottesley Observatory.

On October 9, the balloon left the Crystal Palace at 4^h 49^m P.M., and descended at Pirton Grange, a place thirty-five miles from the place of ascent, at 6^h 30^m P.M.; Robinson's anemometer during this time registered eight miles at the Royal Observatory, Greenwich, as the horizontal movement of the air.

On January 12, the balloon left the Royal Arsenal, Woolwich, at 2^h 8^m P.M., and descended at Lakenheath, a place seventy miles from the place of ascent, at 4^h 10^m P.M.; at the Royal Observatory, by Robinson's anemometer, during this time the motion of the air was six miles only.

On April 6, the balloon left the Royal Arsenal, Woolwich, at 4^h 8^m P.M.: its correct path is not known, as it entered several different currents of air, the earth being invisible owing to the mist; it descended at Sevenoaks, in Kent, at 5^h 37^m P.M., a point fifteen miles from the place of ascent; five miles was registered during this time by Robinson's anemometer, at the Royal Observatory, Greenwich.

From all the experiments, *the velocity of the air at the earth's surface appears to be very much less than at a high elevation.*

Different Currents in the Atmosphere.—The Wind.

1862.—July 30.

The direction of the wind before starting was N.W.

	h.	m.	s.		feet.		
At	4	41	15	at	480	the direction of the wind was	S.W.
„	5	17	30	„	5165	„ „ „ „	N.N.W.
„	5	40	30	„	6183	„ „ „ „	N.

1862.—September 1.

The direction of the wind before starting was E.N.E., verging to E.

	h.	m.	s.		feet.		
At	5	4	0	P.M., at	3268	the direction of the wind	E.N.E.
„	5	10	0	„	3318	„ „ „	E.
„	5	11	30	„	3560	„ „ „	E.S.E.
„	5	17	0	„	3580	„ „ „	E.N.E.
„	5	36	0	„	4190	„ „ „	W.

1863.—March 31.

	h.	m.	s.		feet.		
At	4	58	0	P.M., at	18,302	the direction of the wind was	N.E.
„	4	58	30	„	17,097	„ „ „ „	S.W.
„	5	12	0	„	20,865	„ „ „	nearly W.
„	6	15	0	„	4,441	„ „ „	S.E.
„	6	16	0	„	5,168	moving back again.	

1863.—July 11.

Before starting the wind was E.

	h.	m.	s.		feet.		
At	4	59	30	at	2633	the direction of the wind was	N.
„	7	14	0	„	1876	„ „ „ „	E.
„	7	56	45	„	1020	„ „ „ „	S.E.
„	7	57	0	„	1000	„ „ „ „	W.

1864.—January 12.

	h.	m.	s.		feet.		
At	2	9	0	at	655	the direction of the wind was	N.E.
„	2	14	0	„	1,328	„ „ „ „	E.
„	2	11	0	„	1,518	„ „ „ „	S.W.
„	2	32	0	„	5,401	„ „ „ „	S.
„	3	3	0	„	8,086	„ „ „ „	S.S.W.
„	3	20	0	„	10,017	„ „ „ „	S.S.E.

Comparison of the Temperature of the Dew-point by different Instruments.

In the experiments of every year, there seems to be no certain difference in the determination of the temperature of the dew-point by Daniell's and Regnault's hygrometers, and this temperature determined by the use of the dry- and wet-bulb thermometers seems to be very closely approximate indeed to the results obtained by either of these instruments, as will be seen by the following comparison of the results.

As found from all the simultaneous determinations of the temperature of the dew-point by Daniell's hygrometer and the dry- and wet-bulb thermometers (free),

The temperature of the dew-point by the dry- and wet-bulb (free) up

	feet.		feet.		°		Experiments.
		to	1,000	was	0·1 lower than by Daniell's hygrometer ...from		21
From	1,000	„	2,000	„	0·1 „ „	„	40
„	2,000	„	3,000	„	the same as by „	„	54
„	3,000	„	4,000	„	„ „	„	60
„	4,000	„	5,000	„	0·4 lower than by	„	33
„	5,000	„	6,000	„	0·6 „ „	„	33
„	6,000	„	7,000	„	0·2 „ „	„	34
„	7,000	„	8,000	„	the same as by „	„	8
„	8,000	„	9,000	„	1·5 higher than by	„	2
„	9,000	„	10,000	„	1·2 „ „	„	2
„	10,000	„	11,000	„	0·3 „ „	„	1
„	11,000	„	12,000	„	5·6 lower than by	„	3
„	12,000	„	13,000	„	0·3 higher than by	„	5
„	13,000	„	14,000	„	0·8 lower than by	„	7
„	14,000	„	15,000	„	1·0 „ „	„	2

The number of experiments made up to the height of 7000 feet, varying from 21 to 60 in each 1000 feet as taken in the last three years, is sufficient to enable us to speak with confidence; the results are, that the temperatures of the dew-point as found by

the use of the dry- and wet-bulb thermometers, and my hygrometrical tables, are worthy of full confidence up to this point. At heights exceeding 7000 feet, the three years' experiences do not yield a sufficient number of experiments to give satisfactory results. Before we can speak with certainty at these elevations more experiments must be made.

Let us take the balloon as we find it, and apply it to the uses of vertical ascent; let us make it subservient to the purposes of war—an instrument of legitimate strategy; or employ it to ascend to the verge of our lower atmosphere; and, as it is, the balloon will claim its place among the most important of human inventions, even if it remain an isolated power, and should never become engrafted as the ruling principle of the mechanism we have yet to seek.

INSTRUMENTS.

On the Construction of Double-scale Barometers.

By William Mathews, Jun.

[From the 'Philosophical Magazine' for January 1865.]

To the Editors of the Philosophical Magazine and Journal.

Gentlemen,—In a short paper which you did me the favour to insert in your December number, it was remarked that there was reason to fear that double-scale barometers were not always properly graduated in this country. I was then unaware of the extent to which barometers with incorrect metrical scales have recently been manufactured by the most eminent firms in London. I have in my own possession a standard barometer, two mountain barometers, and a mountain aneroid by four of our first makers, and in each of these the metrical scale is erroneous, while a mountain aneroid by Secretan of Paris is affected by a similar error in the English scale. My friend Mr. Tuckett, of Bristol, who has been investigating this subject simultaneously with myself, informs me that all his instruments are likewise inaccurate.

The nature of the error may be explained as follows:—

Suppose a standard brass yard, divided to inches, at the normal temperature of 62° F., to be laid beside a standard brass metre divided to millimetres at the normal temperature of 32° F., with their zero-points coincident. Then by Guyot's Tables for converting inches into millimetres, at their respective normal temperatures, each inch of the English standard will correspond with 25·39954 millims., and 30 inches with 761·986 millims., or 762 millims. very nearly.

Next, suppose the temperature of the standard metre to be increased 30° F., and so to be made equal to the temperature of the English standard.

The coefficient of the linear expansion of brass per degree F. being..................	0·0000104344
That for 30° will be	0·000313032

Each length of the standard metre which corresponded with the inch of the English scale will have expanded through a space equal to ·00795 millim., and the length which corresponded with 30 inches through ·238 millim.

It is manifest that whatever lengths correspond at the temperature of 60° F. will correspond also at all temperatures common to the two scales.

We have therefore the following relations:—

At the normal temperatures of the standards.	At all common temperatures.
1 inch = 25·39954 millims.	1 inch = 25·3916 millims.
30 inches = 761·986 "	30 inches = 761·748 "

In a large number of double-scale barometers which have recently been examined by my friends and myself, the metrical reading of 762 millims. has been found to coincide exactly with 30 inches, and therefore to be in excess by nearly a quarter of a millimetre. I accordingly requested one of the makers to inform me on what principle he made the graduation. His answer was as follows:—

"I graduate the English scale with great care by comparison with an English standard; I find from Guyot's Conversion-tables that 30 inches = 762 millims. very nearly; I make a mark on the French side of the scale opposite to 30 inches, and by means of a dividing engine I divide the space between that mark and the zero-point into 762 equal parts, which I call millimetres. I believe this method is universally practised in England."

It is obvious that these millimetres are all too short, and that it is impossible that the reading of a metrical scale so constructed can, when reduced, ever agree with the English one.

Mr. Tuckett has prepared a new set of conversion-tables, based on the hypothesis of the two scales having the same temperature, and has distributed them to several of the London makers, most of whom immediately recognized the inaccuracy of the method they had been employing, and promised to correct it for the future. It is of course desirable that the production of inaccurate barometers should be stopped as speedily as possible, and I therefore venture to give a word of advice to purchasers. *When a barometer is offered to you, set the vernier to* 30 *inches, and if the metrical reading should be* 762 *millims., reject the instrument at once.* I trust also that the matter will not be lost sight of at Kew and Greenwich, and that barometers with incorrect metrical scales will no longer be passed without comment when sent to those observatories for examination.

I am, Gentlemen,

Your most obedient Servant,

William Mathews, Jun.

51 Carpenter Road, Edgbaston,
December 12, 1864.

ERRATA.

Page 327, line 4 from top, *for* Rogus *read* Rogers.
Page 355, line last in small table, *for* 50°·9 *read* 59°·9.

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

EDITED BY

JAMES GLAISHER, Esq., F.R.S., Secretary.

Vol. II. 1865, JUNE 21. [No. 20.

S. C. WHITBREAD, Esq., F.R.S., President, in the Chair.

Thomas William Morris, Esq., Belgrave, near Aylesbury, was balloted for and duly elected a Member of the Society.

The names of Three Candidates for admission into the Society were read.

XCIX. *On the Mortality of London, in connexion with the Daily Weather Diagram for* 1864, *and the Comparisons of the Curves of each of the Elements delineated thereon with each other and with the Mortality.* By C. O. F. Cator, Esq., M.A.

In my former paper on this diagram (read by Mr. Glaisher at the Meeting of this Society on April 19, 1865) I briefly considered the curves of the Pressure of the Atmosphere, and the Temperature,—the Rainfall,—and the Direction of the Wind, separately: now, and to some extent in continuation thereof, I propose to consider the weekly mortality of London in connexion with the diagram; and then to consider how the curves of the elements traced thereon seem to have been varied or influenced by each of the

other elements; and, also, how far all or any of them seem to have had any influence on the mortality, in the year 1864, as per the following sketch:—

Sketch or Analysis.

The Mortality.—The weekly numbers of deaths in London are taken from the Registrar General's Weekly Returns. The weekly period of registration ends on Saturday; but it is impossible that the deaths registered in any week can be identical with the deaths in that week: as it is most probable that the deaths on Sunday to Tuesday, inclusive, would be registered on or before the following Saturday, and that the deaths on Friday and Saturday would not be registered until some time in the following week, while those on Wednesday and Thursday might be either in the current or following week, it seems preferable to give one of these two days to each week; and, in order to attribute the recorded mortality to its true date, to consider each week as ending on the Wednesday preceding the Saturday up to which the weekly

returns are made. Thursday to Wednesday is, therefore, the weekly period adopted in the diagram.

The year began with a very high mortality, chiefly from diseases of the respiratory organs, the maximum for the year (2427, of which 837 were from this class) occurring in the week ending January 13. The following week the number was 2180; and these are the only instances of a mortality exceeding 2000 either this year or for many years past, in fact, I believe, the highest ever recorded. The mortality gradually decreased, with slight fluctuations, to the week ending June 1, when 1213 deaths occurred, which was the minimum for the year; it then increased slightly to the end of July. In the two weeks ending July 27 and August 3, the deaths were respectively 1607 and 1595, arising no doubt from the extreme drought and insufficient flushing of the sewers. The numbers then decreased again to the week ending September 21, when 1229 deaths took place; they then increased again to the week ending November 16, 1742 deaths occurring, and from this time continued high, with one exception, to the end of the year. On the whole, it is seen that the mortality is much less in the *summer than in the winter months*.

Comparisons.

Next, to compare the different elements one with another, and with the mortality.

I. First. The *Pressure of the Atmosphere* with each of the other elements. 1. There seems nothing particularly worthy of remark in comparing the fluctuations of the *readings of the barometer* with the *lunations*, &c. 2. In glancing the eye over the diagram, it appears, in comparing the *curve of the barometer* with that of the *mean temperature*, that in most instances where there has been a considerable depression in the barometer, there has also been a depression in the temperature; but that the latter has preceded the former by about one, two, or three days, and that the latter has begun to rise again one, two, or three days before the former; for instance, temperature, after being low, begins to rise a little before the barometer after being low.

TABLE.

Low Temperature.	Low Barometer.	Difference of Days.	Low Temperature.	Low Barometer.	Difference of Days.
Jan. 6–7......	Jan. 8–9......	2	June 13	June 14–15..	1½
No corresponding low temperature	Jan. 22–23.		No corresponding low temperature	July 3.	
Jan. 25	Jan. 28	3	Ditto do...	Aug. 8.	
Feb. 9–10 ...	Feb. 10–12...	1½	Aug 23	Aug. 23	0
Feb. 19–20...	Feb. 21	1½	Sept. 12	Sept. 16	4
Mar. 9	Mar. 9	0	Oct. 15	Oct. 19	4
Mar. 27	Mar. 29	2	Nov. 11	Nov. 15	4
Apr. 16	Apr. 16–17...	½	Nov. 24–25 ..	Nov. 25–26..	1
May 9.........	May 9.........	0	Dec. 10, slight	Dec. 12	2
May 29–30...	May 31	1½			

From this it would seem, if the reading of the barometer has been decreasing while the mean temperature has been decreasing, and continues to do so after the latter has begun to rise, that the former will begin to increase two or three days after the curve of the temperature has begun to take an upward turn. However, I do not mean to try to establish any rule of this kind; but merely think, from the number of instances in this year only, that it is worthy of future examination.

3. There seems to be nothing particular to remark in comparing the *barometric curve* with the *mortality*.

4. In comparing the *barometer-readings* with the *direction of the wind*, it seems that the coming north-easterly wind causes an increase in the barometer-reading, whether it remains high or not, while the north-easterly wind continues; in a good many cases the curve rises for one or two days and then falls for some days, the wind remaining north or east,—for instance, January 1 to 8 rising from 1 to 3, and falling continuously till the 8th. Again, February 4 to 11, rising the first two days, and falling for five days, the north wind prevailing all the time, and a *west-south-west* wind immediately following (which lasted five days) brought an increase in the reading of the barometer of 0·9 of an inch. Then from February 16 to 26, north-east wind, the reading increased rather more than ½ inch in two days and half, and then decreased the same amount in two days, and remained without much variation till February 26; then, with an east wind, it decreased 0·3 in. in six days. Again, March 16 to 24, east-north-east wind, the barometer-reading increased about 0·35 in. in the first thirty-six hours, and then decreased about 0·56 in. in three days, and remained

low four days. Again, April 5 to 15, generally east wind; it increased 0·2 in. in three days and a half, and then fell about 0·62 in. by the 15th. But from April 19 to May 19, with prevailing east wind, it remained pretty steady, with slight fluctuations, and fine and generally warm weather. On May 22, when the north wind again blew, it raised the barometer-reading nearly 0·3 in. in a day and a half, but decreased again gradually till the 31st about 0·55 in., with north wind prevailing. From July 6 to 18, north-east wind prevailed, with a very steady and pretty high barometer. A similar curve, again, as above mentioned, from October 9 to 15, with northerly wind. But from October 25 to November 12, with east-north-east wind, there was not a like curve: in this case the readings increased 1·3 in. in ten days, which was the maximum of the year, followed by the great decrease of about 1·8 in. to the minimum of the year, the first six days of which were with east-north-east wind; and, again, from December 9 to 26, with east and east-north-east wind, there was another dissimilar curve, the barometer-reading increasing most of the time. From these cases, it seems, in the first five months of the year, not that the barometer always remained high with a north-easterly wind, but that for the first two or three days only of its continuance it caused the barometer to rise rather quickly, followed by a gradual fall extending over a much longer period; and in the periods, July 6 to 17, and September 26 to October 15, the curve remained pretty steady; and in the other two periods, October 25 to November 12, and December 10 to 26, the pressure was increasing for a longer time than it was decreasing. In periods with a west or south-west wind, there seems to be no peculiarity in the corresponding figures of the barometric curve, it sometimes being pyramidal, sometimes steady, and sometimes pit-like, the most remarkable being the great rise, 0·9 in February 12 to 14, with west-south-west wind, coming immediately after a low barometer, with north wind. In periods with variable winds, it appears that the curve generally fluctuates a great deal.

5. Then, in comparing the *barometric curve* with the *rainfall*, in nearly all cases of a rainy period a corresponding dip in this curve is observed, as might be expected, except April 5–6, on which 1·064 in. fell, with a high and increasing reading of the barometer, it being the seventh day in a ten days' continuous increase of upwards of an inch; and on August 9, 0·596 in. fell, with a moderately high reading of the barometer, on the first of a five and a half days' continuous increase, it having previously de-

creased 0·25 in., without rain. But mostly rain seems to have fallen while the reading was decreasing, or else while it remained low without decreasing. In the last fortnight of October there were very heavy rains in the North of England and in Scotland, being the wettest period of the year in those parts: the barometer was affected considerably in this locality, although no great quantity of rain fell here.

II. 1. Next, comparing the *lunations* with the *temperature*, the points to be remarked are, that the

New moon on January 9 was coincident with the very sudden rise of temperature above referred to.

New moon on February 8 was coincident with a sudden fall of temperature, 11°·5 in two days.

New moon on April 6 immediately followed the great changes of April 4 and 5, above referred to.

New moon on May 6 was coincident with a rise of 7° in the middle of an otherwise low temperature.

Full moon on May 21 was coincident with a great and sudden fall of 11° of mean temperature, and 18° of maximum temperature.

New moon on June 4 was coincident with a great rise in the temperature after a cold fortnight.

Full moon on July 19 was coincident with the two days of maximum temperature of the month.

New moon on August 2 was coincident with a dip of 10° in the middle of otherwise very hot weather.

Full moon on August 17 ushered in the cold weather from the 17th to the 28th.

New moon on October 30 was coincident with the sudden and decided fall above referred to.

Full moon on November 13 succeeded the end of the cold period (October 30 to November 12); and with it commenced the long period of generally warm weather (November 13), which continued till the next

Full moon of December 13, which brought cold weather, continuing to the end of the year.

Collecting these together, we find that the seven above-mentioned new moons were coincident with four rises and three falls in the mean temperature, and that the five above-mentioned full moons were coincident with two rises and three falls in the mean temperature, from which result it seems that in this year the great changes in the temperature took place chiefly at the time of new and full moons; but that we cannot attribute either a rise or fall

uniformly to either. There do not seem to have been any peculiar changes of temperature at the time of the other new and full moons in 1864, or at the times of any of the first or last quarters.

2. The only thing to be remarked, in taking the *lunations* and the *directions of the wind* together, is that the new moon of April 5 was coincident with the commencement of the very long period of generally easterly wind, which only ceased with the new moon of June 4, thus lasting exactly through two moons. At no other time in the year does there seem to be any particular coincidence of change of moon and change or duration of wind.

3. The *lunations* and the *mortality* seem to be quite independent of one another. 4. But with the *lunations* and the *rainfall* there seem to be some points worthy of note, viz.:—In glancing the eye over the diagram, it is at once struck with the greater proportion of rain which seems to have fallen between the times of the *last quarter* and the *new moon*; in fact, all the rainy peroids of *the year* 1864 seem to have occurred in this particular age of the moon, except that one period of September 13 to 18, which occurred at the time of full moon. The aggregate amounts which fell between the four quarters were as follows:—

Between full and last quarter—

4·542 in., or 25·5 per cent. of yearly total on 40 days.

Between last quarter and new moon—

6·68 in., or 37·5 per cent. of the yearly total on 40 days.

Between new moon and first quarter—

3·922 in., or 22 per cent. of the yearly total on 30 days.

Between first quarter and full moon—

2·648 in., or 14·9 per cent. of the yearly total on 25 days.

Therefore the period between last quarter and new moon was the wettest, and nearly double the amount of that which fell in the period between first quarter and full moon, which was the driest; and the falls in the other two periods were nearly equal. It is also worthy of remark, the rainfalls which occurred at, or set in with, the moon whilst in perigee and in the equator simultaneously, viz. April 5–6, 1·064 in.; May 2 and two following days, 0·548 in.; and September 14 to 18, 1·810 in.

III. 1. *The Temperature and the Direction of the Wind.*—This needs scarcely any remark. It appears at once that north-easterly winds brought cold weather, and especially in the winter; and that the greatest heats in summer occurred with east-south-east and west-south-west winds; moreover south-westerly winds brought warm weather, especially in winter; and the temperature in winter

was very seldom below the average with south-west wind, though often so in summer.

2. *Temperature and Mortality.*—The former seemed to exercise the most marked influence on the latter, as will be seen by looking at the diagram; and the number of deaths seems to be fewest the nearer the temperature is to the mean of the year, and increasing when it falls much below or rises very much above it, but in the former case in a much more marked degree than in the latter. The first week in the year, being very cold, with a mean temperature about 26°·7 at Greenwich, was immediately succeeded by a very great mortality for two weeks, which then decreased every week till the cold week, February 4 to 11, which arrested the decrease; then the number decreased about 60 with the following warm week, then with the next period of very cold weather (February 18 to 27) there was an increase again of 91 and 89 deaths in the next two weeks respectively; afterwards, as the temperature approached nearer the mean of the year, the deaths decreased 370 in three weeks; then with colder weather again there was an increase of about 180 in the last week in March, and they then gradually diminished to 1213, the minimum of the year, at the end of May, when the temperature was about 50°, with the exception of one increase of 120 deaths in that hot week, May 12 to 19; then with the temperature of about 58° till July 13, the numbers of deaths were a little under 1300 weekly; after this, with a great drought and increase of temperature to about 65°, the numbers rose about 300 in two weeks, and remained high till August 3; then in the following week, in the latter part of which the temperature had decreased 14°, the deaths had decreased by 160, and continued generally to decrease to the third week in September, when the number of deaths was nearly down to the minimum of the end of May. Then, notwithstanding the hot ten days from August 29 to September 9, they remain low, but slightly increasing, for about five weeks; and then with a decrease of 18° of themperature, from 53° at the end of October to 35° in the second week in November, the number of deaths increased in the three weeks 330, viz. from 1409 to 1742; and with a succeeding rise in the temperature again to about 45° for four weeks, the deaths gradually decreased 300, to 1449, and again during the last two weeks of the year, the temperature decreasing to about 34°, the deaths rose again 250, viz. to 1697.

3. *Temperature and Rain.*—Generally, the rain seems to have fallen in the winter months with a temperature above the average;

and in the summer, rain seems to lower the temperature, especially 0·59 in. of rain on August 9, which immediately succeeded the hottest period of the year, with a decrease of 11° temperature from August 8; the two heaviest falls in the years, April 5 and November 24, above mentioned, each occurred with a suddenly and much diminished temperature. The very rainy week in middle of September, which consisted almost entirely of heavy showers, was with the temperature about the average for the season.

IV. 1. *The Direction of the Wind and Mortality.*—The former does not seem to exercise directly any particular influence over the mortality, but only through the change of temperature, so far as it is affected by the direction of the wind; for the east wind, which is generally supposed to be unhealthy, was not accompanied, even during its long continuance from April 5 to June 4, by an increasing mortality, but by a decreasing and the lowest mortality of the year, as the temperature then was about the mean of the year. Again, during the last two weeks in July, which were very hot, although with a west-south-west wind, the deaths were high, and increased, as above mentioned, about 300 in two weeks.

2. *Direction of Wind and Rain.*—The greatest amount of rain fell with south-westerly winds; but the two heaviest falls in the years, viz. April 5 and November 24, were with an easterly wind. The 5th of April was peculiar in many particulars, viz. having a very high increasing reading of the barometer, being the seventh of a nearly continuous rise of ten days,—a very sudden fall of 16°·5 in mean temperature from the previous day, having only 6° range of temperature, the day before having a range of 20° or upwards,—the mean temperature of the day was 9° below the average,—it was the first day of the long period of easterly wind, which lasted till June 5 (the change having taken place from west through north to east-north-east), the moon being both in perigee and in the equator, and being the day immediately preceding the new moon,—and in London a fall of rain mixed with snow amounting to 1·064 in., and lasting from about 1 A.M. of the 5th for thirty hours. There was no rain after this, except two slight showers, until May 2, when the moon was again in perigee and in the equator. Preceding this day (April 5) westerly wind had prevailed for eleven days, with the temperature slightly below the average. This fall seems to have been general over the southern, western, and midland counties of England, and also the heaviest fall of this otherwise very dry month, except in the eastern counties north of the Thames. The circumstances of the fall

TABLE showing the Depth of Rain which fell with Wind from

	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January 1·024			·190 ·009		·045 ·003		·002 ·006 ·215			·113	·288 ·035 ·030	·030	·052 ·122 ·014			
February ·941	·040 ·010 ·064	·005	·003 ·008 ·020 ·010	·018	·027 ·135 ·103		·012		·348		·083		·033 ·012		·010	
March 2·375	·049		·503		·131		·010				·420 ·045 ·095 ·038 ·068	·542	·050	·284 ·100	·017 ·023	
April 1·521			·060 ·012	·963	·101						·063	·322				
May 1·807	·120		·480 ·321 ·026 ·270				·212 ·019	·005			·141				·190 ·023	

June 1·347			·037 ·010	·228							·093 ·104	·164 ·149	·040 ·310	·212		
July ·537		·054	·018								·104 ·165	·183		·013		
August 1·358									·234		·053	·596 ·158				·317
September 2·699										·042 ·173 ·408 ·583	·150 ·249 ·023 ·524 ·203	·037 ·122	·030 ·067	·088		
October 1·257			·010 ·012		·013				·513 ·114 ·009		·050 ·433		·078 ·025			
November 2·158			·018		·985		·042 ·018		·070 ·251 ·020		·281 ·113 ·048 ·037	·258				·017
December ·768			·023 ·014 ·123		·083	·066	·009 ·007	·017	·285 ·008	·088	·013				·032	
Totals......	·283	·059	2·177	1·209	1·626	·066	·552	·363	1·511	1·307	3·919	2·561	·833	·697	·295	·334
Days' av. amount	5	2	22	3	10	1	11	5	7	6	27	11	12	5	6	2
Days +·25 in.	......	......	4	2	1	......	......	1	4	2	6	3	1	1	......	1

(November 23–24) were different from the former, viz. a low falling and oscillating barometer,—a fall of only 4°·5 mean temperature from the previous day, a temperature only 3° below the mean,—it was moreover a single day of easterly wind occurring in the middle of twenty-five days of prevailing south and south-west winds, the change in this case being retrograde from south-west to south-east and north-east, and thence after the rain to north-west and south-west,—the moon was in the equator, but the fall preceded the new moon by three days instead of one,—and the fall was 0·985 in. in twelve hours, from 6 P.M. to 6 A.M. It seems to have been general over the southern, south-midland and eastern counties as far north as the Tyne, and also the maximum fall of the month, but not so in the western counties.

The aggregate amounts of rain which fell with the different directions of the wind are shown in the Table, pp. 448, 449; also the number of days, with the different directions of the wind, on which any amount and on which 0·25 in. or upwards fell.

V. Lastly, *Mortality and Rain.*—There seem to be no peculiar features in the increase or decrease of mortality, as consequent on the rainfall, week by week; but the general high mortality throughout the year seems to be to some extent consequent on the very dry year, and great scarcity of water in the summer months. This theory is, of course, supported by the increased mortality at the end of last July, which is well known to have been remarkable for its drought.

C. Col. AUSTEN, *on calling Strong Winds Cyclones, which are not Cyclones.*

As our Society, from its very nature, is especially regarded as the true interpreter of all meteorological phenomena, it is the duty, I conceive, of each of its Members to maintain this its character; and, as occasion or opportunity offers, to endeavour, however humble the effort, to prevent the public from being misled by any pseudo-ex-cathedrâ notice, in a published form, of any current atmospheric phenomena.

Now I rank Mr. Allnatt's letter in the 'Times' of May 30, wherein he announced the advent of a "cyclone" over England that day, as an erroneous averment; but I can quite comprehend the cause of his erroneous conclusion, when I read his inconse-

quential deduction from the state of the sky, that morning; since no cyclone, *per se*, *can* be inferred from such phenomena alone as he there describes. Let any one conversant, indeed, with the compound action of cyclonic storms, in our northern hemisphere, inspect the several *wind-arrows* on this chart, with the numerals of *force* connected therewith, for each day; and it will scarcely then be necessary, I imagine, to *disprove* Mr. Allnatt's assertion; for it is self-evident, from a close consideration of the several winds, at 8 A.M. on those three days, and those that prevailed, at each place, during the twenty-four hours' *interval*, respectively, that it was a very heavy W.S.W. *continuous gale*, mostly extending from Brest to Yarmouth, and so over the North Sea in a N.E. direction, as its eastern limit, and from Cape Clear to Shields, along a similar meridian, as its western boundary (being equivalent, in fact, to a wind-belt 250 miles broad); and this same gale it was that caused the fearful wrecks in the Baltic on the 31st of May, of which the papers have given us such a melancholy record recently.

The following is the letter referred to by Col. Austen:—

"*A Cyclone.*

"*To the Editor of the Times.*

"SIR,—On the morning of Monday, the 29th, a dark canopy of rain-cloud overspread the sky, and a brisk wind of limited range blew from S.W. At 4^h P.M. there were in high atmosphere streams of radiant cirri, below which dark masses of horizontal cumuli were driven by the earth's current; each stratum of cloud moved with varying velocity.

"At 11^h 35^m P.M. long parallel alternate rays of black and grey nimbi, through which the stars were visible, were suddenly projected over the face of the hemisphere, stretching N. and S.; and the wind, which during the day had been variable and gusty, freshened.

"At midnight the nimbi in high atmosphere coalesced with the existing cirri, and assumed the form of an expanded lenticular cirro-stratus, which covered the sky and obscured the stars.

"At 2 o'clock this morning the wind had attained the force of a gale, and from that time until 4 A.M. raged with the fitful violence of a paroxysmal hurricane. It appeared that we were involved in the periphery of a cyclone, whose axis of repose was N.E., and whose radius vector, therefore, would strike with con-

centrated force the Land's End, or most south-west promontory of Cornwall.

"It is to be feared that the northern coasts of France and the south-western shores of England were implicated in its destructive violence.

"I am, Sir, your obedient Servant,
"R. H. ALLNATT."

"Frant, May 30, 1865."

[Col. Austen is quite right in calling attention to the erroneous practice of calling every strong wind a cyclone, whether it possesses any cyclonic property or not.—EDITOR.]

CI. *On Errors of an Aneroid Barometer.* By G. HARVEY SIMMONDS, Esq. In a Letter to Mr. GLAISHER.

YOUR note on Mr. Symons's paper in the last Number of the 'Proceedings' led me to examine the figures given there, and to turn the values in the columns headed "Range" into percentages of the quantities measured. From these percentages (given in the Table below) it will be seen that Mr. Symons's aneroid is no exception to the general rule, as stated by you; for the "Range," which, by-the-bye, is a strange way of giving the error, varies from 7 to 600 per cent. of the quantity determined.

Has not part of Mr. Symons's paper been omitted? I can see nothing in the Tables to show that the variations of level are correctly given by the aneroid, nor that the rapid motion of the train was without effect in equalizing the readings throughout.

"RANGES" in percentages of the quantities measured.

108	308	13	13	167	500	217
233	19	27	13	160	13	11
259	62	38	7	57	21	59
556	22	200	28	46	28	
636	7	12	22	20	77	

P.S. There are one or two mistakes in printing on p. 421: $+\cdot05$ in the third column of differences, first line, should be $+\cdot02$; $+\cdot03$ in the eighth difference column, third line, should be $+\cdot04$; and $\cdot04$ in the "Range" column, fifth line, should be $\cdot07$.

CII. *On the Great Storm which occurred at the Commencement of October* 1864, *in India.* By HENRY F. BLANFORD, Esq. In a Letter to Mr. GLAISHER.

I SEND you by this mail, viâ Southampton, a few copies of a note (on a hail-storm which occurred here about twelve months since) lately published in the 'Journ. Asiat. Soc. of Bengal.' Will you kindly take one for your Society, and distribute the others to any of your Members who may feel interested in the subject? Should you wish for more copies, I shall be happy to send them to you.

It may be interesting to you to know that, in conjunction with Col. Gastull, I am engaged on a memoir on the cyclone of last October. Owing to the absence of regular observatories in India, except at Madras and Calcutta, it has been a somewhat difficult matter to collect observations, and such as we have cannot lay claim to any scientific exactitude; but even from these we have been able to elicit much of interest, bearing on the more striking features of the cyclone, which commenced on the 2nd, a little to the west of the northern Andamans. This was not the same vortex that passed over Calcutta, apparently, and our cyclone did not, I think, extend to the Ganges; but, on the night of the 5th, a third vortex formed, and passed northwards up the Jamoona towards Assam, where it broke up. The proximate cause was a very strong south-westerly current of wind which forced its way up the east of the bay, while a weaker northerly current took possession of the west of the bay. I cannot say much about barometric pressure, as, I fear, most of the observations we have are not very reliable. It is, however, certain that at Calcutta the daily tides were regular on the previous day and up to 8 o'clock in the evening. The movement of the wind-currents was converging towards the vortex, except very close to the centre, where it became spiral. The central calm was rainless, and the sun came out for the half or three-quarters of an hour during which it was passing. From the rate of progress, I calculate the centre to have been about ten miles in diameter. The destruction of life and property were chiefly caused by the cyclone-wave which swept over the low country of the Sonderbans. This has been accurately ascertained; but I have not yet received the reports. The loss of life was, I fear, far greater than was at first believed. It will never be accurately known; but the latest official information estimates it at certainly not less than between 80,000 and 100,000.

Some good has, however, resulted. The Lieut.-Governor of Bengal has appointed a committee to establish systematic daily observations of meteorological phenomena throughout Bengal; and we hope to extend the system to Madras, daily telegrams being sent to a central office in Calcutta. A beginning has, therefore, been made, and it is to be hoped that, in the course of a few years, we may gain some knowledge of the meteorological laws of India and the Bay of Bengal.

CIII. *Notes on the Aurora Borealis of March 20th*, 1865. In communications to Mr. GLAISHER.

At Brighton it presented a pale yellow appearance.

At Clifton it is described as very fine, lasting from $8^h 30^m$ to 11^h P.M.

At Penketh and Silloth it was very brilliant.

At Galway it was seen as an extraordinary luminous arc at $7^h 45^m$ P.M., a few degrees south of the zenith; gradually disappeared about $8^h 15^m$ P.M.

At Eccles at 8^h P.M. there was a strong play of phosphoric light about the sky, and at $8^h 20^m$ it had concentrated itself into a fine arch, stretching across the heavens to the E. and W. of the magnetic pole. At that time it passed exactly between the four stars forming the trapezium in Ursa major, the two stars commonly called the "Pointers" measuring its entire breadth, and the remaining two stars in the trapezium just measuring its breadth likewise. In the W. it just passed exactly under the bright stars Auriga and Aldebaran. It disappeared in about half-an-hour, gradually approaching northward, when the aurora became very powerful on the horizon in the direction of the magnetic pole.

At Cockermouth, when first observed at about $7^h 30^m$ P.M., it was in the form of a narrow band of light, nearly due E. and W., and extending quite down the horizon at each end. It slowly drifted over towards the south, keeping its axis in the same direction, and disappeared at $8^h 30^m$ P.M. The band, when first observed, passed through Usa minor, crossed the zenith, and faded away in the constellation Leo.

At Carlisle a very brilliant aurora borealis made its first appearance about $7^h 30^m$ P.M., springing from the N.E., and extending

right across the heavens towards the S.W. It was situated very low, and quite transparent, the stars shining brightly through it. After being visible about an hour and a half, it finally settled down into a bank in the northern horizon, from which auroral streamers shot up towards the zenith, passed longitudinally through the Greater Bear constellation, and by its breadth covered nearly the whole of the seven stars.

CIV. *On Difference of Winter Temperatures of Greenwich and Newport.* By JOHN C. BLOXAM, Esq. In a Letter to Mr. Glaisher.

Thorncliffe, June 15, 1865.

DEAR MR. GLAISHER,—I have just read your explanation of the difference between the English winter temperature and the French, at page 432 in the last Number of the 'Proceedings.' I have already given just a similar explanation of the difference between the winter temperatures at Greenwich and at Newport. Having reduced your mean daily values by the same method I had used for smoothing my own, I find that the Greenwich minimum falls on January 10, whilst the Newport minimum falls on February 11. The explanation for this is, that at January 10 we have a N.W. wind; and this wind, in approaching Newport, passes over a large sea-surface, whilst at Greenwich it passes over a large land-surface. On February 11 the wind is N.E., and this, passing over land in approaching Newport, brings about a lower temperature than the N.W. did in January, though the sun (independently of wind) would have produced a different result. You make the maximum (daily) temperature to fall on July 15, though you represent the beginning of August as the hottest *period*. Under my method of smoothing, August 3 figures as the hottest day, and the same day belongs to Newport. It seems to me that if such a process as I use brings the hottest day into the hottest period, *this* ought to be appreciated and received as the hottest day.

CV. *Note on Dry- and Wet-bulb Hygrometer.* Communicated by L. P. CASELLA.

IN a letter which I received from J. Cavalier, Esq., the well-known meteorologist of Ostend, dated the 24th of May, 1865, he makes the following instructive remarks upon the use of Mason's hygro-

meter, which I think will be agreeable to this Society:—"I have found the imbibing quality of the cotton and muslin employed with the psychrometer greatly augmented by first washing it in *diluted* sulphuric acid, and afterwards, when well rinsed in clear water, in ammonia; and, further, the incrustation which I have always found to form on the bulb of the thermometer is entirely prevented. This process, you will see, is quite different from that recommended by Mr. Glaisher, viz. carbonate of soda. The acid removes the limy property of the gum, as well as the gum itself, with which all manufactured cotton is more or less impregnated; and the ammonia necessarily destroys any greasy matter that remains."

CVI. *Note on the Hail-storm of the 24th of March.* By HENRY F. BLANFORD, A.R.S.M., F.G.S., Joint Secretary of the Asiatic Society.

[From the 'Proceedings' of the Asiatic Society.]

[PLATE XXVIII.]

THE formation of hail is well known to be one of the most obscure phenomena of meteorology, more especially in the case of hail-stones of unusual size, which, from the very circumstances of the case, must be formed within the space of the few seconds succeeding the consolidation of their nuclei, and during which they are falling in obedience to the law of gravity. In tropical climates, where the temperature at a considerable height from the earth is much above the freezing-point, and where, nevertheless, some of the largest recorded hail-stones have fallen, the stones must attain their maximum dimensions in the first portion of their fall, and during some subsequent seconds must be subject to the liquefying influence of the lower and denser strata of the atmosphere. It has appeared to me, therefore, that a few observations on the stones which fell in Calcutta in a hail-storm on Thursday, the 24th ultimo, may be not without interest as a contribution to this branch of meteorology. For the thermometric, barometric, and anemometric observations I am indebted to Col. Thuillier, the Surveyor-General.

The storm commenced about $5^h\ 45^m$ P.M., the wind being from the south-east, and for a few minutes previous to the fall blowing in strong intermittent gusts, though not stronger than commonly

precede the afternoon showers of this season*. The clouds, a thick mass of nimbus, approached or formed from the north-west, but did not move at any great rate, and indeed they appeared to be stationary during the latter part of the storm. Lightning was frequent and forked, radiating in zigzags from a small mass of cloud to those around, and the thunder was frequent and almost continuous, but not loud. Heavy drops of rain began to fall at $5^h 45^m$, and were soon accompanied by a few hail-stones about the size of hazel-nuts. They were not very numerous, perhaps one or two per square yard per second; and although they increased in frequency and number during the fall, which lasted about half an hour, they were at no time very thick, and were throughout accompanied by rain, which increased in proportion to the hail. As the stones increased in frequency, so also they increased in size, and the largest fell just before the end of the storm.

The form and structure of the stones are noteworthy. They had all of them a more or less oblate or discoid form, some being rudely elliptical in section, while others, and especially the larger, were irregular disks. The exterior was extremely irregular, resembling the extremities of a mass of crystals; but I noticed no regular development of crystalline faces. [It must, however, be remembered that the stones were partially melted at the time of their touching the ground.] The interior (nuclear portion), as seen in a fracture or a partially melted stone (fig. 2 *a*, Pl. XXVIII.), was formed by alternating opake concentric bands (of which in one case I distinguished seven) separated by rings of less opacity; and the outer portion consisted of transparent ice containing numerous air-bubbles†. The air-bubble which escaped from the largest of these when the stone was melted under water was nearly as large as a grain of mignonette-seed. The arrangement of the air-bubbles was irregularly radiate. Many of the more

* At the Botanic Gardens, the stillness of which is more favourable to observation than the noise of Chowringhee, Dr. Anderson noticed that the storm was preceded by a prolonged rushing sound, similar to that which would be produced by a number of railway-trains rushing by at no great distance. This increased gradually, apparently from the north or north by west, and appeared to pass overhead, before the hail fell. The direction of the hail near the ground was from the south-east.

† Dr. Brandis has since furnished me with the accompanying sketches of sections of the stones made by him during the fall. He points out that some had transparent, others opake nuclei. I may also refer to these sketches as independent evidence of the oblateness of form which, as I have above observed, characterized most of the stones.

discoid stones exhibited deep depressions, almost amounting to holes, in their axis, as shown in fig. 3.

The largest of the stones which I noticed were those represented in figs. 1, 2, Pl. XXVIII. The dimensions of the latter of these, taken when first picked up, were, diameter 45 millims., thickness 27 millims. The stone, fig. 4, is represented of its natural size, and its irregularity appears to be due to the coalescence of two nuclei. It is the only one I noticed exhibiting this phenomenon*.

The thunder and lightning continued vividly for half an hour or more after the cessation of the fall; but gradually the clouds dissolved, and by 9^{h} P.M. the sky was clear. The wind continued from the south-east for the remainder of the evening.

The fall was very local. At Serampore there was rain, but no hail ('Friend of India'); at Dum Dum there was no fall simultaneous with that of Calcutta, but a heavy fall occurred about half or three-quarters of an hour later, which Mr. Boulnois, who left Calcutta after the end of the hail-storm, experienced on the road to Dum Dum (but which did not reach Calcutta). At Koolnah, according to the newspapers, there was also a heavy fall, and a stone is said to have fallen there of 5 seers (10 lbs.) in weight. This, however, wants confirmation. The total fall at Calcutta, as estimated by the lower rain-gauge at the Surveyor-General's Observatory, was 1·22 inch.

It would be a point of some interest to ascertain the direction of the wind, temperature, and other meteorological data in the northern parts of Bengal, *e.g.* at Moorshedabad, Purneah, Malda, Kissengunj, &c., in order to determine the causes of this interesting hail-fall. Hail, as is remarked by Sir J. Herschel, seems always to depend on the sudden introduction of an extremely cold current of air into the bosom of a quiescent†, nearly saturated

* This must have been due to an oversight on my part, and my having been engaged in sketching the stones, &c., during the last 5 or 10 minutes of the fall. Dr. Partridge, who lives only at the distance of a furlong, and Dr. Anderson, three miles off, inform me that, during the latter part of the fall, the majority of the stones were agglomerated. From their description these appear not to have been larger than those simple concretions which I have figured. The weight of the largest weighed by Dr. Anderson was 3 drachms. At the reading of the above paper, it was observed by the Hon. Mr. Beadon, and confirmed by other observers, that many of the later stones were very irregular and perfectly transparent lumps of ice. One in particular was described as resembling a double-fanged tooth in form. These appeared to be agglomerated stones.

† The air could scarcely be said to be quiescent in this case, as previous to the storm, and again after its close, the south-east wind blew strongly; but this would be checked when met by a strong northerly current, and an ascending current produced.

mass. Now the dew-point at 5ʰ P.M., as calculated by Apjohn's formula from the observed temperatures of the wet and dry bulbs, was 84°, the dry-bulb thermometer being 86°·6. The air was therefore very near saturation, as might be expected of a heated wind, which had recently swept over many hundred miles of a tropical sea. Were such a wind met by a cold current from the Himalaya, we should have the conditions required to produce hail; but in this case we should expect to find some indications of the northerly current in the direction of the wind, and in a lower temperature, at some of the northern stations. It is not necessary that the temperature of this current should be below the freezing-point. Its collision with the southerly current would cause a sudden rise of both into the higher regions of the atmosphere; and if this were very rapid, the reduction in the temperature consequent upon the expansion of the heated air, aided by the cooling influence of the northerly current, might, I think, reduce the temperature sufficiently to cause the formation of hail. That such an upward current existed is, I think, proved by the barometrical reading, which at 6ʰ P.M. (two hours after the afternoon minimum) gave a reading of 29·712 inches, whereas the corresponding morning reading was 29·811 inches. At the usual period of the afternoon minimum (4 P.M.) the pressure was 29·719 inches, at the morning minimum 29·769 inches.

The clouds were not low during any part of the storm, but it is scarcely probable that the hail was produced in their lower strata. The quantity of rain which accompanied the hail was greater than could well result from the mere partial liquefaction of the hail-stones; and I am inclined therefore to infer that rain fell from the lower strata of cloud, the formation of hail being confined to the upper portions of the mass.

The uniformly concentric structure of such stones as that delineated in fig. 2 *a*, and the air-bubbles of the clear portion, afford interesting indications of the mode of formation of the hail-stones. The clear ice must have been condensed in the fluid form, and have contained a large amount of air in solution, which, as in the formation of lake-ice, was squeezed out at the instant of solidification, forming the air-bubbles now entangled. The concentric zones indicate so many atmospheric strata of condensation; and it is probable that they consist of radiating snow-spicules, *i. e.* ice condensed from vapour below the freezing-point, and crystallizing on a solid nucleus, instead of forming free flakes. On this view each clear zone represents a portion of the stone formed in an atmo-

sphere above the freezing-point, and subsequently frozen, while each opake zone represents that contributed by an atmosphere below 32°. This would show a great variability in the upper strata of cloud; but such might result from the eddying of the mingling currents.

The oblate or discoid form of the stones and their axial hollows are more difficult to explain. Were they in rapid rotation, they might indeed acquire the observed form by centrifugal force; but there is no apparent reason why such a motion should be set up. I do not know that a similar observation has been previously recorded; but the prevalence of the phenomena in the case of the hailstones in the storm recorded proves that it is not accidental, but due to some cause operating generally in their formation.

I bring these remarks forward, in the hope that further observations may be elicited from some of our Members or others on the phenomena of the storm, as well as to draw attention to the importance and interest of this branch of meteorology, in case future storms may afford opportunities of detailed observation.

SUNDRY NOTES.

Rain-fall at Bacup, in the Year 1864, 900 *feet above the sea.*
By G. E. Harrison.

1864.	inches.
January	3·20
February	4·34
March	3·10
April	1·475
May	2·945
June	3·98
July	2·03
August	2·79
September	5·43
October	2·98
November	5·69
December	2·98
Total	40·94

FOREIGN INTELLIGENCE.

Abstract of Meteorological Observations made at Pietermaritzburg, Natal. By Dr. MANN, F.R.A.S., Superintendent-General of Education in the Colony.

Latitude 29° 30′ S.; longitude 30° 2′ E.

Height of the Observatory (Dr. Mann's residence, Pietermaritzburg), above the Custom House, Durban, given by a mean of 80 Barometric Observations by standard and compared instruments, 2095·674 feet.

Month.	Temperature of the Air.								Rain.			
	Highest			Lowest			Mean		Amount fallen.			Number of Days on which it fell in 1863.
	In Six Yrs.	Mean of Six Years.	1863.	In Six Yrs.	Mean of Six Years.	1863.	Of Six Yrs.	1863.	Greatest in last Six Years.	Mean of Six Years.	1863.	
	°	°	°	°	°	°	°	°	inches.	in.	in.	
January	94·0	91·2	91·4	51·8	56·2	59·0	71·0	72·4	4·87	3·06	1·80	14
February ...	97·1	91·4	88·4	55·8	58·4	58·0	71·8	71·4	5·53	3·80	5·53	23
March	92·8	87·8	85·8	42·0	50·8	54·4	69·6	70·2	3·62	2·31	2·91	13
April	89·5	85·7	83·0	40·2	45·2	50·0	65·3	66·1	1·85	1·62	1·70	13
May	82·4	78·7	76·8	36·4	39·5	40·8	59·2	57·6	2·95	1·05	2·95	4
June	78·2	75·7	73·2	32·0	35·7	35·2	55·7	53·7	0·09	0·13	0·09	1
July	82·2	78·6	75·0	29·0	34·4	36·4	59·4	57·0	0·75	0·29	0·75	5
August	89·8	84·2	81·4	34·8	37·5	36·8	59·6	59·5	3·15	1·26	0·21	3
September ...	95·4	91·5	92·2	38·0	42·8	38·0	65·0	62·2	2·83	1·25	1·76	8
October	95·0	89·1	84·8	46·2	49·0	49·2	65·2	65·9	7·22	3·58	7·22	18
November ...	94·6	90·0	94·6	45·6	51·5	50·2	67·0	66·4	8·20	4·73	3·76	16
December ...	93·4	91·5	91·2	54·4	56·5	57·2	70·1	70·5	6·00	5·04	6·00	19

The fall of rain in 1858 was 27·42 in., in 1859 was 28·40 in., in 1860 was 30·60 in., in 1861 was 22·41 in., in 1862 was 29·97 in., in 1863 was 34·66 in.

The mean of the six years is 28·91 in.

Average number of rainy days for each of the months of May, June, July, and August is 3.

Average number of rainy days for each of the remaining eight wet months is 15½.

Number of days on which rain fell for the entire year is 137.

The number of thunder-storms at Maritzburg, in the year 1863, was 59; the average for six years is 54.

The number of hot winds in the year 1863 was 21; and the average for six years is 25.

The highest reading of the barometer in six years was 28·474 in., the lowest was 27·215 in., and the mean 27·879 in.; in 1863 the

mean was 27·914 in., and the extremes were 28·362 in. and 27·369 in.

The mean daily fall of the barometer between 9 A.M. and 3 P.M. is 0·081 in.; and the mean daily rise between 3 P.M. and 9 P.M. is 0·094 in.

The mean temperature of the year, from six years' observations, is	64°·6
The mean highest „ „ „	95·4
The mean lowest „ „ „	33·4
The highest temperature in six years was	97·8
The lowest „ „ „	29·0
The mean temperature in the year 1863 was	64·4
The highest „ „ „ „	94·6
The lowest „ „ „ „	35·2

The average moisture of the air at 9 A.M. for the year 1863, was 72°·8; that is to say, each cubic foot of air had about 6 grains of water in it, and could have taken up 2 grains more before it was saturated. The average moisture at 3 P.M. was 62°·3, representing a state in which there was 6 grains of water in each cubic foot and capacity for 3½ grains more. The average moisture at 9 P.M. was 73°·4, representing a state a trifle more moist than at 9 A.M. The driest air, occurring during a hot wind, gave 28° of moisture, representing a state of air in which each cubic foot of air had only 5¼ grains of water in it, and could have taken up 12½ grains more. This driest state of the atmosphere was on the afternoon of September 29th, on the third day of a hot wind, and two days after the 'Sebastian' and 'Earl of Hardwicke' were blown on shore.

During the year 1863 there were 71 days of unbroken cloud, and 65 days of uninterrupted sunshine; 229 days were of mingled cloud and sunshine.

At 9 A.M. the wind was blowing north 88, north-east 62, east 52, south-east 39, south 28, south-west 62, west 36, and north-west 35 times. At 3 P.M. the wind was blowing north 28, north-east 23, east 131, south-east 128, south 26, south-west 8, west 5, and north-west 7 times. At 9 P.M. the wind was blowing north 20, north-east 10, east 71, south-east 92, south 79, south-west 45, west 38 times, and north-west once. The morning winds were more generally distributed than at any other period of the day, the north-east and south-west winds being both more frequent than the rest. In the afternoon the east and south-east winds were predominant over all the rest in the proportion of 259 to 106. In the evening the east and south winds still remained predominant, although in an inferior degree.

The characteristic peculiarity of the tropical climate, viewed in contrast with the temperate, is, that a comparatively high temperature is sustained throughout the year, and that there is a tendency to recurring and regular periods of rain-fall. Hence the seasons are marked as wet and dry, rather than as winter and

summer. Within the tropics, indeed, there is no winter, properly so called. Thus, at the island of Mauritius, which is 150 miles within the southern tropic, the lowest temperature of the mid-winter, at the level of the sea, is 68° of Fahrenheit's scale—a temperature which would be held to be very pleasant and genial in the summer of England. The mechanism and meaning of the periodical tropical rain-fall, when no disturbing influences affect it, are simply this:—The fall more or less closely attends upon the vertical sun. When the sun shines most directly down, its warming power acts most intensely; and therefore the air becomes highly heated and rarefied. It is converted into a kind of universal balloon, and, according to its balloon nature, soars away into higher realms. Regions vertically warmed by the sun, are, for the time, the *chimney*, so to speak, of the earth. So soon as the solar fire is lit, up flies the heated atmosphere through the chimney-shaft. What wind there is in this particular position is an *upcast* wind, barely noticed at the place. To the north and to the south of that place, the wind sets powerfully in from either hand, to feed the upcast. These feeding-winds come sweeping over the sea, laden with moisture. As they get warmer and warmer, they become more thirsty, and more tolerant of the water which they bear. Hence, in the regions where they blow there is no rain-fall. The water is absorbed into the thirsty air, instead of being precipitated as rain. When once, however, the air-currents are fairly engaged in the upcast, the matter is altogether changed. As the air rises higher and higher, it is more chilled by the temperature of high space, and more expanded under the influence of diminished atmospheric pressure. As this chilling and expansion go on, the absorbed moisture is squeezed more and more out of the air. First it collects into clouds, and then it condenses still further into the tropical downpour. Electrical disturbance accompanies the rain, because the natural balance of the electrical forces is deranged by the motion and expansion of the air, and by the change of invisible and absorbed vapour into visible mist and palpable water. Wherever the sun is vertical twice in the year (as it is in the neighbourhood of the equator), there are also two rainy seasons in the twelve months. Where the sun is only vertical once in the year, as it is close on the circles of the tropics themselves, there is one rainy season. In regions just outside of the tropics there is also the single rainy season; but there the rain-fall is necessarily less heavy and less continued. The tropical character is shown in a softened and modified degree.

The colony of Natal is a land just out of the tropics. A traveller, proceeding due north from Maritzburg, would find himself at a spot where the midday sun would shine vertically upon his head at the end of December, before he had journeyed 400 miles. Natal therefore has its rainy and dry season. But it also has the inestimable advantage of the ghost of a winter—a winter in which the hardy colonist can dispense with the domestic fireside, but in which the cold of the night is amply sufficient to be reinvigorating and refreshing. Natal has also the further incalculable

benefit of having its rainy season broken into fragments, and lengthened out. Its soil is moistened through months, instead of being deluged through a few brief and passing hours, and baked into a desert afterwards. The physical peculiarities which so far modify the tropical influence as to secure these advantages for Natal are, for the most part, as obvious as they are interesting.

During a considerable portion of the year, the coast of Natal lies quite within the fair and average range of the southern trade-wind—that is, of the great world-wide air-current which feeds the tropical upcast from the south, and which gets an easterly set, because, as it advances, it brings a comparatively slow rotatory velocity to parts of the earth that are whirling round from west to east with greater absolute speed. But this south-east wind is reinforced along the coast of Natal by a second very powerful influence acting in the same general direction. The sun shining at high altitude, day by day, heats the land more intensely than the sea; and the land so heated lies to the north-west of the great ocean. There is therefore a strong indraft from the sea upon the land lying in the direct course of the trade-winds—that is, from the south-east to the north-west. The south-easterly winds of Natal are thus, to a considerable extent, trade-winds and monsoons and sea-breezes fused together and commingled. The wind was blowing east or south-east, at Maritzburg, in the middle of the day, on 259 days during the past year, from these combined influences.

The south-east wind, which thus sets in upon the coast of Natal almost daily, is a sea wind, and on that account an essentially moist one. Its moisture is not diminished by the fact that for the last part of its course, before it strikes the shore, it crosses a strong and broad warm ocean-current, setting down from the north-east, and running parallel to the coast. This current is, in reality, the overflow of the Pacific and Indian Oceans—the great offset of the whirl communicated to the mobile water of those wide seas by the earth's rotation. This band of warm water confers a higher and more even temperature upon the east coast of Africa than it would otherwise possess, and reaching Natal from the north, and sun-warmed, as it is, it adds its free contribution of vapour to the sea-breeze. If this breeze coursed along a flat low surface of land, it would soon be itself heated sufficiently to sustain, in comparative permanence, its heavy load of vapour. But, instead of this, it is thrown at once up an ascending slope of land which reaches above a mile high within seventy-five miles of the shore. Maritzburg itself is about 2095 feet above the sea. The Accommodation House halfway between Durban and Maritzburg is 316 feet higher than the southern entrance of the city. North of Maritzburg, the high road crosses an elevation of 3833 feet before it descends to the Umgeni, and of 5206 feet (within seventy-four feet of a mile) before it reaches the Mooi River; and the surrounding hill-tops are considerably above the road. The consequence is, that the sea-breeze soon arrives at an altitude where, partly from chill and partly from diminished atmospheric

pressure, it is no longer able to sustain its watery load. Then the mists accumulate and the rain descends. If the elevated land were always chill, it would be clothed with eternal vapours and clouds; but it is itself subject to scorching sunshine. Hence it is able to aid the ascending air in maintaining its vapour until the increasing heat of the day establishes a chimney upcast, as well as a climbing sea-breeze. Then the usual convulsion of the tropical locality is set up in miniature. The clouds gather, and thunder-storms rage, until the high region of the air is relieved of its excessive burthen of accumulated vapour. About fifty-four thunder-storms occur in the year at Maritzburg, and these happen almost exclusively in the eight hottest months of the year. Only four storms, on the average, occur during the four coldest months of the year. Rain fell upon 124 days at Maritzburg during the eight hottest months of the past year, and on thirteen days during the four coldest months. The average annual rain-fall at Maritzburg during six years has been 28·91 inches. The greatest annual rain-fall in that period 34·66 inches, and the least 20·15 inches. The rain-fall on the leeward (Port Louis) side of the island of Mauritius last year was 28·38 inches, and the number of days on which rain fell 133—a result which shows a curious approximation to the state of things, in this particular at least, in Maritzburg. The mean annual rain-fall of London is 25·42 inches, and the number of days on which rain falls there in the year about 175.

As a general rule, atmospheric pressure varies less in tropical regions than it does in temperate or cold ones. The extreme range of the barometer in London is about 1·99 inch (that is, approximately, 2 inches, or a fifteenth part of the pressure of the entire atmosphere). The extreme range of the Mauritius for the last year was 0·60 of an inch. The extreme range in Maritzburg, during five years, was 1·25 inch; but the greatest range during any year in that period was 1·089 inch. The mean or average atmospheric pressure at Maritzburg (2095 feet above the sea), for six years, was 27·879 inches of mercury. There is a daily wave of the atmosphere (due to the increased rarefaction of the air by the daily sunshine), amounting to 0·09 of an inch, at Maritzburg; the wave dipping to its lowest trough two or three hours after noon. But, in addition to these little wavelets, there are greater billows of the air continually sweeping along over the land. These greater billows vary between four and seven in the month; and their crests correspond with the lowest temperatures, and their troughs with the highest temperatures. Hot winds are invariably concomitant with a low dip of the air-waves. The thunder-storms nearly always occur also with the troughs; but the mercury, for the most part, begins to rise, and the wind to blow somewhat strongly from the south-east, before the actual burst of the storm. The storms nearly always occur late in the late afternoon, when the mercury is rising after the diurnal dip. The general rule is, that the barometer falls more and more for three or four days. After this the mercury rises for three or four days, and there are no more storms until the wave is again well over the crest, and far on

its descent. A barometer of 28·3 inches is a high barometer at Maritzburg, and one of 27·5 inches a low one. Rain comes with both high and low barometers at Maritzburg. The low barometers bring interrupted and heavy storm rains, and the high barometers the more continuous rains of strong sea-gales. The waves of the atmosphere very strikingly express the incessant vicissitudes of the climate. They are eternally going up or down. A quiescent pressure of the atmosphere, and a steady barometer, are things never to be found in Natal.

The temperature in Natal is as restless and capricious as the pressure of the air. In the month of November of the past year, the thermometer was standing one day at noon at 94° of Fahrenheit in the shade, and the general aspect was that of being in the midst of an Indian summer. At 2 P.M. of that same day the temperature was down to 84°. The highest temperature of the following day was the pleasantly low one of 77°, and in the night of that day the thermometer descended to 57°. Vicissitudes of this character are of frequent occurrence. It is a very rare thing indeed for a high temperature to be maintained for three days in succession. In the hottest month of the last year, there were four days when the temperature did not rise to 70°, and twelve days when it did not rise to 80°. In the coldest month, there were eight days in which the temperature rose to 70°, and only three days in which it did not rise to 60°. In the coldest months the intervals of actual cold are very brief, and there are constant breaks of even summer warmth. It will be seen that the thermometer occasionally rises above 90° in seven months of the twelve, and that it occasionally rises to 82° in eleven months of the twelve. In the hottest months the intervals of distressing heat are alike transient and intermingled with stretches of pleasant coolness. In the hot season the vicissitudes occur mainly between successive days; in the cool season between day and night. The reason for this is, that in the hot season the midday heat is more frequently broken down and tempered by thunder-storms, clouds, and rain; while in the cold season it is more frequently sustained by the uninterrupted sunshine and cloudless sky.

The mean temperature of Maritzburg is 64°·6 of Fahrenheit's thermometer scale—a trifle higher than the mean temperature of the hottest months of the year in London; but this city has an extreme range of temperature amounting to 68°. The highest temperature of six years has been 97°·1, and the lowest temperature 29°. Extreme temperatures of this class occur, however, but very rarely. The heat has been up to 90° only fourteen times in the last two years, and down to 36° only eight times in the same period.

The mean temperature of Maritzburg is just 14° higher than that of London, which is about 50°·5.

It is, perhaps, not unworthy of note that the cold of the dry season became more and more marked from the year 1858 down, through a progressive series of years, to 1861. The greatest cold of 1858, at Maritzburg, was 38°·0; of 1859, 34°·8; of 1860, 31°·4;

and of 1861, 29°. The mean temperature of 1858 was 64°·90; the mean temperature of 1859, 64°·95; the mean temperature of 1860, 64°·43; the mean temperature of 1861, 64°·27; the mean temperature of 1862, 64°·47; and the mean temperature of 1863, 64°·40.

The most distressing feature in the climate of Maritzburg is the occasional occurrence of hot winds—that is, land-winds sweeping down from the north-west with great violence. The highest summer heat of Maritzburg, without the hot wind, is only 84°: all the temperatures above this are brought by the South African sirocco. This wind is painfully scorching and dry. It commonly blows when there are not more than 5 grains of water in each cubic foot of air, and with a temperature that would enable the cubic foot to take up other 12 grains in addition without manifesting palpable moisture. The wind, therefore, drinks liquid from almost everything it touches. The hot wind rarely blows, however, more than a few hours at a time. It generally commences early in the morning, and is replaced soon after noon by a strong south-east breeze, which springs up quite suddenly, and heralds a thunder-storm. During the last six years the hot wind has blown upon an average twenty-five times in the year. It has occurred about once, on the average, in the months of January, February, March, April, and June; about twice in the months of May, July, and December; about three times in August and November; four times in the month of October; and more than five times in the month of September. November, August, October, and September are therefore properly the hot-wind months.

The hot wind is obviously the complementary current of the trade-wind. High above the south-east trades a strong north-west current is eternally blowing, to carry back the aërial substance which those winds transport from the further southern latitudes. A similar upper compensatory current is commonly experienced on the summit of the Peak of Teneriffe when the north-east trade-winds are blowing strongly along the base of the island. The north-west wind is, no doubt, the natural and prevalent current of our higher atmosphere. It is experienced as a strong wind, because it never breaks down into the lower regions of our atmosphere, unless driven to do so by very great and violent disturbance of the aërial balance: it is a hot wind because, when such violent disturbance takes place, it reaches Natal from many hundred miles in the interior of the continent, where it has been sweeping along over dry, sun-burnt plains. If it were not for the influence of the earth's rotation, it would be simply a north wind produced by a sudden reversal of the great chimney-like upcast of the vertical sun. It is a west wind as well as a north wind because it brings great eastward rotatory velocity to parts of the earth that are whirling with inferior speed. In all probability, one-half its force is due to this whirling velocity. Upon the whole, it is a very interesting phenomenon to the meteorologist, whatever it may be to colonists at large. An extended and prolonged series of observations is yet required to determine what the immediate causes

are, that give rise to these periodic reversals of the ordinary movements of the air. It is a very remarkable fact that the hot wind of Natal does not extend to the actual coast. It is scarcely ever experienced at Durban. There is generally a gentle east or north-east wind at the bay when the north-west sirocco is in force at Maritzburg. The upper atmospheric current sometimes descends as far as the city is concerned, but it does not dip so low as the port. In other words, the disturbing cause, strong and violent as it may be, is not able to overrule the ordinary surface-currents quite to the sea-level. What becomes of the sirocco between Maritzburg and the coast is one of the curious points that have yet to be determined.

There is some ground for the suspicion that the main and characteristic currents of the atmosphere are more constantly and steadily exhibited at the height of Maritzburg than they are at the sea-level. The true south-east breeze is very much less frequent at Durban than it is at the city. Some local influence seems, at the sea-level, to deflect the main current upwards or downwards along the coast. North-east and south-west winds are much less uncommon at Durban than they are at Maritzburg. During the last year, the north-east wind was blowing 95 times, and the south-west wind 115 times, for eleven hundred evenly distributed observations, at Maritzburg.

As a general rule, the wet season in Natal may be considered to consist of eight months of the year—September, October, November, December, January, February, March, and April; and the dry season of the four months May, June, July, and August. Rain, in greater or less quantity, fell on only seventy-three days during the four dry months of the last six years—that is, on twelve days in each year upon the average, or three days in each month. The actual rain-fall in these months, during the six years, was 16·41 inches—giving 2·73 inches for the dry months of each year, and 0·68 inch for each dry month on the average. The fall in the months of June and July in the six years was, however, 2·54 inches, or at the rate of 0·42 inch per year, and 0·21 inch per month. June and July, therefore, are the essentially dry months at Maritzburg. Rain fell on only twenty-one days in the months of June and July, during the six years. Perhaps, in strict accuracy, the months of October, November, December, January, February, and March should be held to constitute the wet season, the months of June and July the dry season, and the remaining four months, April, May, August, September, a fine intermediate season of moderate and occasional rains. The average monthly rain-fall for the months of the dry season, for the last six years, was—June, 0·13 of an inch; July, 0·29 of an inch. The average fall for the intermediate months during the same period,—April, 1·61 inch; May, 1·05 inch; August, 1·26 inch; September, 1·24 inch. For the months of the wet seasons of the same period, it stands,—March, 2·30 inches; January, 3·06 inches; February, 3·80 inches; October, 3·57 inches; November, 4·72 inches; and December, 5·04 inches.

The rainy season commenced, on the six successive years from 1858 downwards, on October 3, September 24, August 31, October 1, September 29, September 28; and the dry season of the same series of years on April 7, April 18, April 25, April 18, May 2, and April 26.

During the past year (1863), the month of January was hot and rather dry. February was wet and very cool; a sudden fall of the temperature occurred on the 12th of the month, and continued with but slight modification to the end. There was an unusual fall of rain on the 23rd, 24th, and 25th of May, amounting in the whole to more than 2¾ inches. The greatest cold of the season occurred on the 18th and 19th of June. There was again a very cold period from the 30th of July to the 3rd of August, during which the temperature descended each night to 37° or 38°, and ranged between 61° and 70° at midday. The month of August was very fine, with cool nights and warm days, the steadiness of the fine weather being interrupted only on the 18th, when the day and night temperatures nearly met at 60°, and a rain-fall of ⅛th of an inch occurred. September was in a state of incessant perturbation, both as regards temperature and air-pressure. There were six great waves of temperature and air-pressure during the month, the former ranging between 38° and 92°, and the latter between 27·5 and 28·3 inches of mercury. On the 26th a heavy gale occurred on the coast, blowing for a short time with exceeding violence, and driving the 'Sebastian' and 'Earl of Hardwicke' ashore at Durban. The barometer stood at 28·2 inches at Maritzburg two days before the gale, and then began to fall. By the afternoon of the 26th, when the gale occurred, it had fallen $\frac{4}{10}$ths of an inch. In the ensuing night the descent continued rather more than another $\frac{1}{10}$th of an inch, and $\frac{4}{10}$ths of an inch of rain fell. In the morning of the 27th a hot wind began to blow, which continued to blow for three days, with a transient break in the afternoon of the 27th, during a thunder-storm, carrying the mercury of the barometer down still lower, until it stood at 27·5 inches in the mornings of the 28th and 29th, and nearly $\frac{2}{10}$ths of an inch higher during the intervening night. The south-east wind then set in steadily, and the temperature continued to fall, and the air-pressure to rise, until the 2nd of October, which was therefore the apex of the next air-wave. The midday temperature stood at 65° two days before the gale, and at 92° the third day after the gale, at the termination of the hot wind. The Durban gale, therefore, took place about the middle of the descent of an air-wave, with a slope of five days, and heralded in the very unusual circumstance of a three days' hot wind, or sirocco, at Maritzburg. The gale occurred three days before the lowest dip of the barometer, and the night before the commencement of the hot blast at Maritzburg. It was beyond all question connected with the same source of disturbed balance of atmosphere which brought the South African sirocco to Maritzburg. The month of October was of unusually even temperature and of unprecedented wetness. Rain fell on eighteen days, and the entire fall during

the month amounted to 7½ inches. Nearly 5 inches fell between the 19th and the 24th of the month; and at this period there were seven thunder-storms, on seven successive days, during which a blue gum in the town was struck by lightning. Between the 14th and 26th the temperature, both day and night, confined itself to the range lying between 60° and 79°.

The month of November was cool and rather dry, the rain-fall being an inch below the usual average in six years. December was warm and wet, the rain-fall being an inch above the average in six years. There were four thunder-storms on successive days between the 12th and 15th of December, during which 4 inches of rain fell, and the flag-staff at Fort Napier and a blue gum in the town were struck by lightning. The present wet season has proved to be one of almost unprecedented wetness. More than 28⅓ inches of rain fell during the five wet months from October 1863 to February 1864; and there were fifteen days on which rain fell in the first three weeks of the month of February. A destructive hail-storm passed over Maritzburg from the south-west on the 25th of January, 1864, during which rounded hail-stones 1½ inch in diameter, and weighing 2 drachms, fell. A blue gum was struck by lightning in the town on the day of the hail-storm, and the chimney of the Victoria Club was injured by lightning four days subsequently.

ANNUAL GENERAL MEETING.

1865, June 21.

The business of the Ordinary Meeting having terminated, the Annual General Meeting was held, and the following Report of the Council was read.

REPORT.

In accordance with the annual custom, your Council have framed the following Report, containing a brief summary of the progress of magnetical and meteorological science during the past year.

The papers which have been read at our Meetings have possessed much interest, and frequent interesting discussions have followed. Those on the "Aqueous Vapour in relation to Atmospheric Air," by Professor Lamont, and on "Radiant Points of Shooting-stars," by A. Herschel, Esq., and on "Secular Changes of Temperature," by our Secretary, may be especially mentioned.

The past year has done very little indeed in the preparation of ozone test-paper; those prepared by Mr. Lowe have yielded results which in the hands of the Army Medical Department have not been found satisfactory, and at the present time there is no ozone test-paper that does not seem to give results of a variable character. Mr. Lowe has paid great attention to this subject; he has made a large number of experiments, and gone to great expense, and it is probable that success will ultimately crown his endeavours. It has happened unfortunately that Mr. Coupland, of Harrogate, who undertook to prepare ozone test-papers under the immediate direction of Dr. Moffatt, has been suffering for many months from severe illness.

In all ozone test-papers for determining oxidizing agency of the air, it is imperatively necessary that they should be of one preparation, and if possible should be perfectly uniform in their action.

During the past year our Secretary, Mr. Glaisher, has brought his balloon experiments to a close for the present. All his leisure for three years he has devoted to this work; and he has made no

less than twenty-five ascents for scientific purposes. The general results of these experiments were stated in a recent Number of the 'Proceedings,' so that it is unnecessary to reproduce them here; but we cannot avoid pointing out the very important results obtained on the decline of temperature with elevation, in the different seasons of the year; the different amounts of water diffused in the air at the different elevations; and the fact that at every elevation and in every instance water was present, though usually very small in amount at great elevations; nevertheless its presence to considerable amounts at times, proved by the existence of clouds of different modifications, even including nimbi at heights exceeding four miles, and the presence of cirri at very great heights indeed, tends to show that vapour diffuses itself throughout the atmosphere of air.

One other remarkable series of experiments was made in these ascents, viz. those on the radiation of solar heat. The readings of different instruments, when fully exposed to the sun's rays at great heights, were found to be but little affected, and were very nearly the same as those of instruments carefully screened from the direct influence of the sun; and Mr. Glaisher from these draws the following important conclusion, indicating a new link in the chain of our knowledge, that the several members of our solar system are united together by receiving heat from the sun, in precisely the same manner, and possibly to the same amount, as the earth. From the several experiments it would seem highly probable that the heat-rays from the sun pass through space without loss, and become affective where wanted only, and in proportion to the density of the atmosphere, or the amount of water present through which they pass; and if so, the proportion of the heat received at Mercury and Venus, Jupiter and Saturn, may be the same as that received at the earth, if the constituents of their atmospheres be the same as that of the earth, and greater if the density be greater; so that the affective solar heat at the superior planets, Jupiter and Saturn, may be greater than at the inferior planets, Venus and Mercury, notwithstanding their far greater distances from the sun.

The determination that aneroid barometers may be made accurately for the indication of very low pressures, and that the dry- and wet-bulb thermometers, as ordinarily used, can be used with safety and certainty to great elevations, together with the determination that the results by Daniell's hygrometer are identical with those by Regnault's hygrometer, are points of the utmost value to determine, together with those shown in the last Number. These results in the 'Proceedings' show the important bearing of balloon researches on meteorology, and how much the physical conditions of the higher atmosphere exercise an influence over the lower.

RAIN-FALL.—The praiseworthy collection of rain-fall observations which Mr. Symons commenced in the year 1859 has been con-

tinued without interruption, and with great success. The number of stations in his last publication are no less than about 900, and his correspondents amount to fully 1100 upon this subject.

THE METEOROLOGICAL OFFICE OF THE BOARD OF TRADE.—No important change had taken place in the formation of the daily weather-tables, and forecasts of the probable weather for the two following days, until the lamented death of its superintendent Vice-Admiral FitzRoy; and, so far as we know, no successor has as yet been appointed to succeed him in the duties of this office.

From the beginning of this year the Registrar-General has published the weekly results of meteorological observations taken at Greenwich, Liverpool, Manchester, Birmingham, Leeds, and Bristol, with the weekly mortality of those towns. The daily observations are forwarded to Mr. Glaisher, who discusses them, and forwards the results to the Registrar-General in London, another copy being sent to the Registrar-General of Scotland at his request.

In the Report for the year 1863, reference was made to arrangements for systematic meteorological observations wherever any part of the British army may be located.

Full sets of instruments, consisting of standard barometer, dry- and wet-bulb thermometers, maximum and minimum thermometers for temperature of the air, and for solar and terrestrial radiation, a Robinson's anemometer, ozone papers, and rain-gauges, one on the ground and the other at a height above the ground, have been sent to the following stations:—

Edinburgh.
Aberdeen.
Belfast.
Dublin.
Cork.
Curragh.
Aldershot.
Netley.
Colchester.
Woolwich.
Chatham.
Shorncliffe.
Portsmouth.
Guernsey.
Devonport.
Gibraltar.
Malta.
Bermuda.
Quebec.
Montreal.
Halifax.
Barbadoes.
Up Park, Jamaica.
Newcastle, Jamaica.
St. Helena.
Graham's Town, Cape.
Ninera Ellia, Ceylon.
Colomba, Ceylon.
Hong Kong.
Constantinople (for the use of an officer of the R.E.).

The following stations have been supplied with sets of thermometers alone, consisting of dry- and wet-bulb thermometers, maximum and minimum for air, and rain-gauges on ground:—

Preston.	Athlone.
Sheerness.	Kandy, Ceylon.
Walmer.	Tricomalee, Ceylon.
Dover.	Gambia.
Canterbury.	Sierra Leone.
Winchester.	Fort Napier, Natal.
Parkhurst, I. W.	Kingston, Canada.
Jersey.	Newfoundland.
Buttevant.	Bahamas.
Limerick.	Honduras.
Templemore.	Auckland, N. Z.
Fermoy.	

The illness of our late lamented President, Dr. R. Dundas Thomson, prevented him taking any part in the business of the Society during the whole year, and so far checked all dependent on him. At his lamented decease, our Vice-President, S. C. Whitbread, Esq., F.R.S., was elected President for the remainder of the year, and has kindly performed the duties since that time. No further steps have been taken with respect to the Charter; but, with a new President, the question will again have to be taken into consideration.

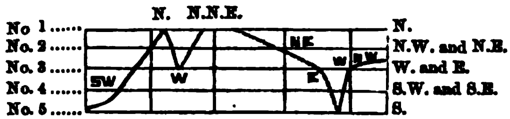
INSTRUMENTS.—Very little progress has been made in the character of instruments during the past year. Mr. Casella has, however, directed his attention to the construction of a delicate anemometer for light winds; should he succeed in the construction of this instrument, it will be applicable to determine the rate of motion of air in mines and passages, and be of much value. He also has been occupied in the construction of a very convenient azimuth and altitude compass. Mr. Hicks, our new Member, is paying much attention to the construction of barometers and other meteorological instruments; and Mr. Browning has brought forward a new form of direct-vision spectroscope, which possesses great advantages on the score of portability and the facility with which it can be used, while its performance is all that can be desired. With as low a power as five, it shows the line D clearly divided in the solar spectrum. Mr. Browning has also introduced a very convenient and efficient level, intended for the use of alpine tourists, in connexion with the aneroid barometer, an instrument to which he has given special attention. Mr. Pastorelli has also been, with our Secretary, in consultation respecting improvements in barometers.

Mr. Cator's new anemometer has been made during the past year, and is erected at Kew Observatory; S. B. Howlett, Esq., of

the War Office, is applying himself to improvements in anemometers at low pressures; Mr. Read has been long engaged in bringing to useful application an ingenious arrangement for anemometrical records at a moderate price; he proposes a new method of registering the direction of the wind, by an instrument to be produced at a cost considerably *less* than that of those anemometers now in use.

By his method, the *direction* of the curves of barometric pressure, temperature, and direction of wind are made as a rule to coincide, and any abnormal curves thrust themselves upon the attention of the observer. His wind-curve paper has five horizontal lines indicating points of the compass.

No. 1 stands for north.
No. 2 stands for north-west and north-east.
No. 3 stands for west and east.
No. 4 stands for south-west and south-east.
No. 5 stands for south.



[A distance of about half an inch between each line.]

To avoid confusion arising from two points of the compass being represented by one line, all movements on the east side of the wind-rose are marked by a red-chalk pencil; all movements on the west side of the wind-rose, by a black pencil. Hence the altitude of any point of the curve will determine the distance from the wind-poles; and the colour of the curve will show from which side of the wind-rose the current is from.

By this instrument, the movements of the pencils are confined between lines Nos. 1 and 5. Saving is thus employed in the amount of room required and the consequent dimensions and *portability* of the instrument, at the same time that there is no chance, on the occasion of several revolutions, of the vane of the pencil running over the margin of the recording-sheet, and thus failing to register.

Curves are, as usual, drawn from left to right, vertical lines dividing the sheet into equal periods of time, as in ordinary sheets.

To those who keep *graphic* registers of the weather, and who are in a position to note the various changes of the wind, the above curve is recommended, substituting perhaps (for convenience sake) a dotted black line for the coloured chalk.

In speaking of those Institutions in Great Britain which especially devote themselves to the investigation of meteorology and kindred sciences, the Royal Observatory, Greenwich, claims our first attention.

The history of the Magnetical and Meteorological Department of the Royal Observatory, Greenwich, during the past year is extremely interesting and important, and the several modifications (which had been projected and in part performed at the date of our last Annual Report) have been completely and satisfactorily carried out. We shall have great pleasure, in the following statement, in pointing out the several alterations and additions which have been made in this department; and it will at once be seen, that although these matters have temporarily retarded the work of this Observatory, yet it has suffered no diminution in activity, but has rather extended its sphere of useful and unremitting exertion.

The arrangements for adapting to use the subterranean room of the Magnetic Observatory (now called the "Magnetic Basement"), to which we referred in our last Annual Report (*vide* 'Proc. Brit. Meteor. Soc.' vol. ii. p. 237) have been carried out with perfect success. The extreme difference of temperature between summer and winter is found to be about 6°, the greatest variation in any one day about 2°; the temperature never differs much from 60° (all in Fahrenheit's scale).

MAGNETIC INSTRUMENTS. *Magnetometers.*—The following are the arrangements for the suspension and mounting of the several magnetometers in their new positions.

The lower declination-magnet is carried by a pier built of brick and slate, whose upper part or suspension-piece protrudes through the floor of the upper room, for the sake of giving greater length to the suspending-wire, and for making the suspension-piece more accessible. This instrument is used for photographic self-registration only.

Upon the superstructure of this pier is planted the original framed wooden stand, for carrying the original 2-feet magnet vertically above the photographic magnet. Hitherto, this magnet has been so mounted that its attached collimator was right or left of it; it is now so mounted that the collimator is above or below it; and with this arrangement, on reversing the collimator and giving the necessary movement for making the collimator-axis coincide with the axis of the theodolite-telescope, the magnet is still vertically above the photographic magnet in the basement.

The theodolite, with which the magnet-collimator is viewed, and with which circumpolar stars are also viewed, is in the same position as formerly, a brick pier being built up from the ground below the floor of the Magnetic Basement, through the basement, and through the floor of the upper room, to carry the theodolite.

For the support of the horizontal-force magnet, a pier is built of brick, stone, and slate, which, like that of the declination-photographic magnet, projects through the upper floor into the upper room; and the vertical-force magnet is also mounted upon a substantial pier built of brick and stone.

We will now proceed to speak of the magnetometers themselves and their state during the past year.

The upper declination-magnet was suspended on 1864, May 27,

and the lower photographic-declination magnetometer was made available for photographs on June 25. Both were suspended on steel wires of no greater strength than was necessary for safety. Under the pressure of business, the determination of various constants of adjustment was deferred to the end of the year. The immediate results of observation, however, began to excite suspicion; and after a time it was found that, in spite of the length of the suspending wire (about 8 feet), the torsion-coefficient was not much less than $\frac{1}{8}$. The wires were promptly dismounted, and silk skeins substituted for them. With these, the torsion-coefficient is about $\frac{1}{210}$. The two magnets have now been in use, suspended by the silk skeins, since 1865, January 20 and 30.

The horizontal-force magnetometer was carried by a loop wire of about half the strength of that for the declination magnetometer; its photographs commenced also on June 25. The experience of the wires for the declination magnets was sufficient to demand the immediate removal of that of the horizontal-force magnet. A silk skein was applied, and has been in use since 1865, February 8. In this year, as in former years, the observations for adjustment were so planned, as to make it certain that the magnet's mean position is transverse to the magnetic meridian.

The new vertical-force magnetometer was mounted in the summer of 1864, nearly at the same time as the others; but various troubles arose in the use of it. Its magnetic power (as stated in the last Report) was too small, but it was found that the steel was imperperfectly magnetized; a proper dose of magnetism was given by Mr. Simms, on June 15. Various irregularities followed, and the knife-edge was changed for a stronger bar. The cause of these troubles was at length discovered, in the accidental contact of a small spring which presses the mirror used for eye-observations. After the instrument had been got into satisfactory action, it was found that one of the adjusting weights was a little unsteady, the effect of a small inequality in the diameter of the screw-stalk. This was remedied, and the instrument is now in a very fine state. Its scale of indications is large; small disturbances are shown in great perfection, and the dislocations in the photographic curves (which had been constantly experienced in past years) have now entirely ceased.

For many years past, however, it has appeared that, notwithstanding these dislocations, the instrumental zero has undergone no change; and that, with little attention, the small portion of the curve affected by the unfair strain may be corrected with almost ultimate accuracy; and this process was in fact used in measuring the hourly ordinates for the investigation of the diurnal inequalities ending with 1857 (in the accompanying reduction of magnetic storms there was no instance of dislocation). This opinion is confirmed, by comparison of some of the Greenwich photographs, in which the dislocations were very sensible, with some of the Kew observations, in which the dislocations are very small. As far as it depends on this cause alone, the photographs with the old instrument may be made nearly as good as those with

the new one, although inferior as regards the magnitude of the scale and the requirement of correction for the temperature.

As regards this latter correction, viz. the correction for temperature, great doubt still prevails as to the amount of the temperature-coefficient. In the years 1846 and 1847 experiments were made for the determination of the coefficients for temperature for the horizontal-force magnet and vertical-force magnet, in which the magnets were immersed in water of various temperatures. It is evident, however, that this form of experiment does not exactly reproduce the circumstances of a magnet whose temperature depends on that of the external atmosphere; and experiments were long contemplated in which the magnet should be heated, not by water, but by air.

Opportunity seemed to be given, in the year 1864, by the command of the hot-air stove, constructed entirely of copper, and heated by gas, which was provided for the warming of the Magnetic Basement. A copper box was prepared to fix on the top of this stove, containing facilities for the placing of the magnet (to be tried) in a definite position, for the distribution of the heated air over its length, and for reading three thermometers in different parts of its length. The degree of heat was regulated merely by turning the tap of the gas-pipe at the floor—a manipulation which could not affect any part of the apparatus. The stove was placed in a position convenient for producing deviation, by the magnet inclosed in the copper box, on the needle of the Kew unifilar.

The result of these experiments is, to give a coefficient for temperature-correction four or five times as great as that given by the water-heatings. And this applies to both the magnets (horizontal-force and old vertical-force), in which the two systems of experiment can be compared. A large coefficient is also given for the new vertical-force magnet, though much smaller than that for the old one, when tried in the same manner.

No peculiarity can be discovered in the apparatus which could produce the smallest error.

The only differences between the modes of action in the two experiments were, that in the former or water-experiments the magnet was "end-on" to the deflected magnet, while in the latter or air-experiments it was "broadside-on"; and that in the former experiments the magnet travelled round to a position definite with regard to the axis of the deflected magnet (in which case its power is measured by the sine of deviation), whereas in the latter it was stationary (in which case its power is measured by the tangent of deviation).

Since these determinations by means of heated air, no further experiments have been made for the temperature-coefficients of the several magnets by the use of hot water or any other method. The values obtained by the hot-air method (as before stated) were so large that they have not been used in reducing the observations, although nothing could be seen in the process to suggest error.

The Astronomer Royal, in his Annual Report, says:—"It is possible that magnetism may have been developed in the stove and magnet-box, both made of copper, by the heat; if this should prove correct, it would throw doubts on the results obtained with water in a copper vessel." Processes depending on the comparison of the results on warm days and on cold days he absolutely rejects, as assuming a knowledge of the absence of connexion between magnetical and meteorological phenomena on which we have no right to presume. This matter is regarded as still involved in difficulty, although as relating to the correction of the Greenwich results, now obtained in almost uniform temperature, it is of little importance; but as a physical problem, affecting other magnetical determinations, it is important, and appears well to deserve the attention of experimental institutions.

Some singular observations have been made on the effect produced by the copper dampers which surround the declination and horizontal-force magnetometers upon those magnets. These dampers were made by Messrs. Vivian & Sons, of Swansea, of copper fresh from the smelting; and, as far as the manufacturer's art could secure it, they contained no iron; and, upon experimenting on them at the Royal Observatory, in the year 1841, no magnetic effect could be discovered. A lately published theory by Dr. Lamont, on the "Effect of Dampers in limiting the Magnitude of Diurnal and other small inequalities," has again drawn attention to this subject, and experiments have been made with the damper surrounding the declination magnetometer; first, by vibrations with and without the damper, which led to no very certain result; secondly, by slewing the damper, and the effect of this is very curious. When the damper is in the position in which it has been many years, every slew of the damper is accompanied by a drag of the magnet in the same direction, to an angular extent equal to about $\frac{1}{120}$ of the angle of slew of the damper. When the damper is reversed (S. to N.), a slew of the damper produces no discoverable effect. It seems from this that the damper acts by two magnetic powers of equal magnitude, exactly analogous to those which in iron ships we call "subpermanent magnetism" and "transient induced magnetism," and that their two forces, in one position of the damper (namely, that in which it has always been used), combine their effects, and in the opposite position neutralize each other. The point appears worthy the attention of experimental institutions. It would seem that the exhibited inequalities are too small by $\frac{1}{120}$ part, a matter of little importance in itself. But it is not easy to say, whether this power has grown up gradually or suddenly; and it is a delicate practical question, whether the damper should or should not be now retained in the same position.

The damper of the horizontal-force magnetometer (which has been for many years in a magnetic E. and W. position), when placed to encircle the declination-magnet, possesses no power of checking its vibrations; and observations will shortly be made, with this damper, similar to those made with the declination-damper, to test its effect upon its own magnet.

Photographic registers were obtained from the three magnetometers during nearly the latter half of 1864, but the instrumental difficulties which have been described make it doubtful whether great value can be attached to them. Since the month of January of 1865 the records are irreproachable, and the series is perfect. All necessary eye-observations are properly kept up. The mean magnetic declination for 1864 is about 20° 38′, but this value is subject to some uncertainty. It is not proposed to undertake a complete reduction of the magnetometer photograms for the second half of 1864. In freedom from constant error they are not comparable to those of 1863 and 1865; and in the representation of diurnal and other inequalities, their indications are too small. They may however be available on some disputed points, and they will be kept in a fit state for reference.

Earth-current Apparatus.—After numerous delays, the apparatus for the self-registration of spontaneous earth-currents was brought into a working state in the month of March 1865. Two wires are led to the Royal Observatory, one from Croydon and one from Dartford; they communicate with the earth at both extremities, but in every other part they are carefully insulated. The apparatus upon which they act is in the Magnetic Basement. Each of them, by means of coils of the usual form, deflects a suspended magnet. The currents are found to be so unexpectedly strong that it has been necessary in each, first, to place the two magnetized needles with poles in the same direction (instead of in opposing directions), secondly, to diminish materially the number of wires in the coil. The light from one lamp falls upon both sets of apparatus; in each case it first falls upon a cylindrical lens with axis vertical, then upon a plane mirror carried by the magnet, then upon a more powerful system of cylindrical lenses with axis horizontal or parallel to the axis of the revolving barrel. The barrel is of ebonite, prepared by S. W. Silver and Co., covered with photographic paper; it revolves once in twenty-four hours. The ebonite discoloured the first three or four sheets of photographic paper; but its power of acting chemically seems to have been rapidly exhausted, and the sheets are now perfectly clean.

The first effective register of earth-currents, with the needles and coils of the recording instrument in the form now adopted for use, took place on April 6. More lately, a natural base-line has been introduced, by simply interrupting the continuity of the wire, when the needle soon settles to rest, and the trace becomes a straight line.

Dip-Instrument.—The history of the dip-instrument during the year just elapsed is important.

In discussing all the observations made since the introduction of the new instrument, it was found totally impossible to infer from them the value of the zenith-point (or reading of the circle when the dipping-needle is vertical). The instrument is adapted to needles of three different lengths (3, 6, 9 inches), and the difficulty was felt equally with all. It then appeared that this course was philosophically wrong, in attempting to infer the value of a

purely geometrical element from observations so foreign in their nature and so defective in their accuracy as magnetical dips, when an independent and accurate determination might with ease be obtained. Mr. Simms was therefore directed to construct a zenith-point needle of brass; with pivots similar to those of the dip-needles; and with three pairs of points corresponding to the three lengths of needles used; loaded at one end so as to take a position perfectly definite with respect to the direction of gravity; to be observed with the microscopes, and to be reversed, exactly as the dip-needles. This small apparatus is considered to be a valuable adjunct to the dip-instrument, as giving the means of deducing independently a separate result from every one of the observations made in the several positions of the needle.

It will be remembered that, in many successive years, the difficulties have been adverted to, which had been experienced in the determination of magnetical dips, and that doubt was expressed in our last Report as to the certainty of the accordance of dip-determinations obtained in other places. This doubt has, however, been removed by the use of dip-instruments specially provided from Kew: the Committee of the Kew Observatory having courteously acceded to the request (in the course of last autumn) that two of their dip-instruments should be placed for a time at the Royal Observatory, in order that observations might be made with them. The dips with these instruments were found to be accordant to a degree never before witnessed, and there is no doubt that they *do* bear a consistency equal to, or comparable with, that which is claimed for them. It happened that Mr. Simms, by whom the Greenwich instruments were prepared, and who had personally witnessed the difficulties experienced with those instruments, was present during some of these experiments; and on the dip-instrument being placed in his hands (November 10–19) for another purpose, he spontaneously repolished the apparently faultless agate bearings. On again using the instrument it was at once found that the inconsistencies of every kind had entirely or almost entirely vanished, and that on raising and lowering the needles, they returned to the same readings; and the dips with the same needle since then appear to be generally consistent.

No care had been spared to make the agate edges perfect. Those of the old instrument were prepared by Mr. Robinson, and were revised by Mr. Barrow; those of the new instrument were made by Mr. Simms. In using the services of the three confessedly best artists of Britain, it was thought that security as to the character of the workmanship had been obtained; and, indeed, what else could have been done?

As the greatest enemy to success in instrumental constructions is secrecy on the manipulation adopted, all known information will here be given as to the methods actually employed. On a very close examination of Robinson's agates, Mr. Simms sees concavities, suggesting to him the idea that, after being shaped (perhaps by some inefficient process) with coarse emery, the surfaces were immediately polished with tin-oxide or other polishing

power carried by a cloth. Mr. Simms's first agate edges, after being roughly shaped, were brought to form with coarse emery, then ground with fine emery, and then polished with rottenstone-powder, all carried by the same leaden tool; the form of the tool admitted of cross-stroke, and it is believed that the only fault in the process was that the cross-stroke was used too freely. The same agate edges were brought to their present state by the use successively of fine emery and tin-oxide, carried by a brass tool which nearly fitted the agates, and which scarcely permitted cross-strokes; and the strokes were almost entirely longitudinal.

It cannot be seen, however, how this change of treatment can account for the removal of the discordances formerly observed; and these discordances are still regarded as authentic facts of observation, the study of which may not improbably lead to important conclusions on the nature of magnetization and the nature of pivot-bearing.

The mean value of the dip for the year 1864 is about 68° 4′; but this number, owing to the above-mentioned difficulties, is subject to some uncertainty. At the present time the dip is very nearly 68°.

Deflexion-Instrument.—The deflexion-instrument used for absolute determination of horizontal force, which is similar to those used in the Kew Observatory, has been constantly used throughout the past year, and observations have generally been made about twice each month.

Meteorological Instruments.—The meteorological apparatus is in an efficient state. Of the class of instruments adapted to eye-observation, and showing the indications at the moment, there are barometer, dry-bulb and wet-bulb thermometers, anemometer, electrometers, and thermometers sunk to various depths below the surface of the soil (the latter, however, only being read once daily). Of those instruments which record accumulations without definition of time, and require daily reading, there are Robinson's anemometer and pluviometers (six to be read once or twice a day, and one to be read once in a month); whilst of those which record maximum and minimum values, there are maximum and minimum thermometers in the air, maximum and minimum thermometers for radiation from the sun or to the sky (all read twice a day), and thermometers of the same class in the Thames (read once a day). The following instruments record their indications continually, with definition of time:—the barometer (registered photographically on the same vertical cylinder as the vertical-force magnetometer), the dry and wet thermometers (registered photographically on opposite sides of a vertical cylinder revolving in forty-eight hours), and Osler's anemometer and pluviometer (registering, by pencil-marks, the direction and force of the wind, and the fall of the rain, upon a flat sheet made to travel by a clock. All these instruments are in good order, and have been in constant use throughout the past year.

The actinometer is in serviceable condition, and has been used

on forty-five days, and sixty sets of observations have been obtained.

The public barometer, of which mention was made in the last Report, has been mounted near the entrance-gate of the Observatory, and is a subject of great interest: giving valuable information, not only to the public, but also to the Observatory,—changes of great magnitude (which may have occurred during the interval between regular observations) being readily seen before reference can be made to the photographed changes. It constantly exhibits the present reading of the barometer, and the last maximum and last minimum since 9^h P.M. of the preceding evening.

It is at present under consideration whether an addition should not be made to the establishment of self-recording instruments, in the shape of a self-registering electrometer (constructed on principles explained by Professor William Thomson), which has lately been introduced to public notice. This instrument would undoubtedly be a great addition to the electrical instruments now employed, which (as above mentioned) are adapted to eye-observations only, and are far from competent to record the various manifestations in an active electrical storm.

Special meteorological observations are taken every morning for publication in the Bulletin circulated by M. Le Verrier; and the London District Telegraph Company and the Submarine Telegraph Company give gratuitously the services of their establishments for immediate transmission of the results to M. Le Verrier. The liberality of commercial bodies in lending the aid of their powerful organizations to scientific enterprise has been long known, but in no instance is it more remarkable than in the continued devotion of personal service and instrumental equipment which has been contributed by these two companies.

The number of complete revolutions in the direction N., E., S., W., made by the vane of Osler's anemometer in the year 1864, was +17·2.

It has been thought desirable to prefix to the magnetical and meteorological observations of 1863 an introduction of nearly the same length and in nearly the same terms as that for the observations of 1862.

The number of copies printed, as for many years past, is 600. Of these, 350 are bound in the 'Greenwich Observations,' which work includes the Observatory's annual publications of every kind; 250 are circulated, as separate copies, among institutions and persons more particularly interested in magnetism and meteorology.

For 1864, the abstracts of dip-observations and deflexion-observations are prepared; and this probably is the whole of the magnetical work to be printed. In the meteorological section, the left-hand pages of the monthly abstracts, and several tables of abstracts which follow, are generally ready for printing.

Photographic operations.—The chemical process adopted in the photographic operations has lately been revised, and sheets obtained by this process have been compared with others produced

by one totally different, and the result has been to show that the process employed at Greenwich (which is described in detail in late Introductions to the printed 'Magnetical Results') is the best in use. No other appears competent to register very sudden changes in the instrumental indications.

RADCLIFFE OBSERVATORY, OXFORD.—The self-registration of the atmospheric pressure, temperature, and humidity of the air by means of photography have been continuous, as well as the mechanical registration of the velocity and direction of the wind, which have been kept up without interruption. The daily results are exhibited with the monthly values, and the diurnal inequalities of mean monthly elements derived from the two-hourly indications of the photographic instruments are shown as they have been at this Observatory since the year 1857.

Four rain-gauges are used at this Observatory; and Mr. Main not only determines the amount of rain collected in each month, but its distribution under the different directions of the wind. The heights of the gauges are as follows:—on the ground, and 22, 24, and 112 feet above it respectively.

LIVERPOOL OBSERVATORY.—The observations have been continued with great regularity, and the same attention has been paid to the anemometrical results as in previous years.

EDINBURGH OBSERVATORY has been occupied in deducing from observations made at the fifty-five of the stations of the Meteorological Society of Scotland the returns required for the Monthly and Quarterly Reports of the Registrar-General of Scotland.

GLASGOW OBSERVATORY.—The usual observations have been taken morning and evening. A Robinson anemometer has been recently added to the establishment, with the view of obtaining indications of the velocity of the wind. It has been placed in a very favourable position, and is found to work well. Besides contributing towards a better knowledge of the climate of the district round Glasgow, the meteorological observations which are regularly recorded at the Observatory have been found serviceable in a way which the public would not so easily suspect. In connexion with questions under litigation, letters are frequently addressed to the Observatory requesting information respecting the amount of rainfall, the force and direction of the wind, or the state of the weather in general, on some particular day; and it is well known that evidence of this kind, derived from the records of the Observatory, has recently exercised an important influence on more than one legal decision.

The results of the meteorological observations are communicated monthly to the Scottish Meteorological Society. An abstract of a few of the results is also forwarded weekly to the Registrar-

General in Edinburgh, and is published in connexion with the weekly statement of births, deaths, and marriages in the eight principal towns of Scotland.

IN FRANCE a Scientific Association has been formed, assisted by the Imperial Observatory, realizing in France our principle of voluntary association of many observers, working on a uniform system well organized and spreading all over the country. The central meetings of this association have been within the walls of the Observatory, but other meetings have taken place in every department.

IN SPAIN, the observations in the several meteorological observatories are made regularly, and the results are transmitted to England.

In presenting his first Annual Report, your Librarian desires to allude to the important services rendered to the Society by his predecessor, Mr. H. S. Eaton, whose untiring exertions have brought the Library to a most satisfactory condition. Instead of a mere heap of rubbish stowed away in boxes, it now numbers nearly 700 volumes, the majority being well bound.

The progress during the last year is satisfactory. Ninety-seven new works have been added to the Library, many of a valuable character*.

Owing to alterations in the offices of Mr. Beardmore, 30 Great George Street, Westminster, where the books had been located for some time past, it was feared that the library would have to be removed. This gentleman has, however, consented still to house them as long as circumstances will permit. On this account, therefore, it is desirable for the Society to have rooms of its own, and especially as Members do not now consult the books in any great numbers. This is owing, partly, to their inability to remain and consult any particular work on the spot, and partly to their ignorance of new works presented†. It is suggested that, if Members wish for any book, they should write to the Librarian a day or two before the Meeting; it will then be brought, and can be taken away at the conclusion of the Meeting.

The Society has to regret the death of several of its Members, especially of its President, Dr. Thomson.

The deceased Members are—

Admiral Robert FitzRoy, F.R.S., F.R.A.S., F.R.G.S., who had been elected into the Society on March 27, 1855.

Alderman Thomas Hopkins, elected on December 10, 1850.

J. Lake, Esq., C.E., elected on March 19, 1862.

Robert Dundas Thomson, Esq., M.D., F.R.S. L. & E., elected June 4, 1850.

* A list of donors is herewith appended.

† It is intended in future 'Proceedings' to publish short notices of all works presented since the previous Meeting.

Dr. THOMSON, who was one of the earliest Members of this Society, filled the offices of Member of Council, Vice-President, and President, with such regularity, zeal, and urbanity as to win for himself the respect and regard of all those with whom he acted.

Dr. Robert Dundas Thomson was the second son of the Rev. James Thomson, D.D., Minister of Eccles, Berwickshire, and was born on the 21st of September, 1810. After a preliminary education at Dunse, he studied Arts and Medicine in the Universities of Edinburgh and Glasgow, and took the degrees of M.D. and C.M. at Glasgow in 1831. He then devoted a considerable portion of his time to the study of Chemistry, under his distinguished uncle Dr. Thomas Thomson, and subsequently made a voyage to India and China in the service of the East India Company. About the year 1837 he settled in London as a physician, and took an active part in establishing the Bleinheim Street School of Medicine, in which he delivered lectures on chemistry, and made numerous researches on the constitution of organic bodies, especially of food, and the blood. He was employed by Government to make a series of analyses of the food of cattle, and of the water supplied to the inhabitants of London. The analyses of food were held in high estimation, and long served as the data on which most of the physiological theories of diet were based

In 1840 he studied chemistry under the illustrious Liebig. In 1841 he left London, where he had obtained a good position, for Glasgow, to assist his uncle in his chemical labours. When his uncle died in 1852, he became a candidate for the Professorship, but did not succeed in consequence of the political influence exerted against him. He then returned to London, and was employed by Sir Robert Peel to make the investigations on barley and malt above referred to, and in 1854 to analyse the London water. In 1856, Dr. Thomson was elected, after a severe struggle, to the post of Medical Officer of Health to Marylebone, and performed the duties, as might have been expected, firmly, discreetly, and with such tact as to obtain the support of the vestry in most of his propositions for the sanitary well-being of the inhabitants. He took an active part in establishing the Association of Medical Officers of Health; edited, conjointly with the late Mr. Pittard and with Dr. Tripe, the 'Weekly Returns of Sickness and Meteorology of London,' and was after a time elected President of the Association. He also made for the Registrar-General a monthly analysis of the water supplied by the London companies, and thus assisted most materially in improving the quality of the water supplied to the inhabitants of London. About six months before his death, his countenance began to indicate the existence of serious disease; and he died on the 17th of August, 1864, from cancer.

Dr. Thomson was Physican to the Scottish Hospital and the Fore Street Dispensary; Fellow of the Royal Societies of London and Edinburgh; editor of the 'Records of General Science' in 1835 and 1836, and of the 'British Annual' in 1837, 1838, and 1839; author of 'Experimental Researches on the Food of Animals,' 1846, 'School of Chemistry,' 1848, 'Cyclopedia of Chemistry,' 1854,

"Chemical Researches on Cholera," &c., in 'Med.-Chir. Trans.,' 'Report to Government on the Waters and Atmosphere of London,' 1854, 'Analytical Reports to Registrar-General on Waters of London,' 1857–64, and of numerous papers in the medical journals.

Vice-Admiral FITZROY was born on July 5, 1805, at Ampton Hall, Suffolk. He was the youngest son of General Lord Charles FitzRoy, by his second wife, Frances Anne, eldest daughter of the first Marquis of Londonderry. In February 1818, he entered the Royal Naval College, Portsmouth.

On October 19, 1819, he was appointed to the 'Owen Glendower,' then coasting between Brazil and Northern Peru. In 1821 he joined the 'Hind,' and served two years in the Mediterranean. At an examination in the Royal Naval College, Portsmouth, in July 1824, he obtained the first place among twenty-six candidates, and was promoted immediately. In 1825 he joined the 'Thetis;' and in 1828 he was appointed to the 'Ganges' and soon after flag-lieutenant at Rio Janeiro. In November 1828 Mr. FitzRoy was made commander of the 'Beagle,' a vessel employed in surveying the shores of Patagonia, Terra del Fuego, Chili, and Peru. In the winter of 1829, during an absence of thirty-two days from his ship, in a whaleboat, he explored the Jerome Channel, and discovered the Otway and Skyring Waters. On December 3, 1834, he was promoted to the rank of Captain, but remained in command of the 'Beagle,' pursuing his hydrographical duties, making surveys, and carrying a chain of meridian distances round the globe.

Captain FitzRoy was elected an Elder Brother of the Trinity House in 1839, and sat in the House of Commons as a Member for Durham in 1841. He was appointed acting Conservator of the Mersey in September 21, 1842. He went out as Governor of New Zealand in April 1843, and was succeeded in that office by Sir George Grey in 1846. He became Rear-Admiral in 1857, and Vice-Admiral in 1863.

When, in 1854, the Meteorological Department of the Board of Trade was established, Captain FitzRoy was placed at its head, and to him are owing the storm-signals and other models of warning that are now in use for the benefit of seamen. He was elected a Member of our Society in March 1855, and filled the offices of Member of Council and Vice-President respectively for several years, and continued in the Society till the time of his death, viz. April 30, 1865.

M. MATHIEU (DE LA DRÔME) died on March 17, at Romain (Drôme), in France, aged 57. M. Mathieu (de la Drôme), the famous weather-prophet (who was named from his département in order to distinguish him from the many Mathieus who are dispersed over France), was during the earlier part of his career an ardent politician. He was among the Representatives who were arrested on the night of the *coup d'état*. Banished from France, he first took up his residence in Belgium, which he afterwards ex-

changed for Chambery. He then gave up politics, and on his return to France, on the promulgation of the amnesty, devoted himself to science. For the last five or six years of his life, however, he applied himself exclusively to the study of meteorology and the publication of his Almanacks, which soon gained an immense circulation. It may be that chance favoured him; but it is certain that several of M. Mathieu's forecasts were fulfilled, and the weather which in August last he announced would prevail in five months of that year has actually been experienced. Among the lower classes along the sea-coast, M. Mathieu was looked upon as a prophet.

Alexandre Dumas, speaking of Naples, says, "Educated people think that Mathieu is a prophet, not, like Calchas and Jeremiah, by divine inspiration, but in the same way as Nostradamus and Mathieu Lænsburg, by the study of natural phenomena. The lower orders simply believe that he is a sorcerer."

It is said that M. Mathieu, some months before his death, feeling that his end was approaching, disclosed to his son-in-law, M. Neyret, at Marseilles, journalist, his method of calculation on on which he based his weather-predictions, and that the famous *Almanack* which brought him wealth and fame will be continued by his heirs.

The following Papers have been read at the Ordinary Meetings during the Session 1864–65:—

1. "On the Relation of the Atmospheric Air to the Aqueous Vapour existing therein." By Professor Lamont. (Translated by W. T. Lynn, Esq., B.A., F.R.A.S., of the Royal Observatory, Greenwich).
2. "On the Aurora Australis of 8th June, 1864." By F. Abbott, Esq., of Hobart Town.
3. "Observation on a Luminous Meteor observed at Hobart Town." By F. Abbott, Esq.
4. "On Lind's Anemometer." By Arthur Forbes, Esq., of Culloden.
5. "Some Remarks on the Ten-year Period of the Magnetic Variation and of the Solar Spots." By Dr. J. Lamont. (Translated by W. T. Lynn, Esq., B.A., F.R.A.S.)
6. "Remarks on the Weather at Culloden in October 1864." By Arthur Forbes, Esq.
7. "On the Great Storm of July 11th, 1863, in Russia." By Bryan Donkin, Esq., Jun. In a letter to his Uncle.
8. "On the Great Storm of July 11th, 1863, at Kondrona in Russia." By W. Howard, Esq. Communicated by Bryan Donkin, Esq.
9. "General Radiant-points of Shooting Stars, derived from Catalogue of Shooting Stars in the Reports of the British Association." By A. S. Herschel, Esq., B.A., and R. P. Greg, Esq., F.G.S.
10. "Observations of Meteor Showers, and their Radiants." By R. P. Greg, Esq., F.G.S.

11. "On the Mean Temperature of every Day from all Thermometrical Observations, taken at the Royal Observatory, Greenwich, from the Year 1814 to the end of 1863." By James Glaisher, Esq., F.R.S.
12. "On the Secular Increase of Mean Temperature." By James Glaisher, Esq., F.R.S.
13. "On a Method of Obviating Parallax in reading off Thermometers." By Lieut.-Col. Strange, F.R.S., For. Secretary.
14. "On the Pressure and Diffusion of Elastic Fluids." By John Bloxam, Esq., M.B.M.S.
15. "On the General Weather of Europe during the Month of January 1865." By A. J. Cuming, Esq., Librarian.
16. "Notes on the Climate of Southland." By Charles Rous Marten, Esq., of the Observatory, Martendale, Royal Bush, New Zealand.
17. "Meteorological History of Southland." By C. R. Marten, Esq.
18. "Natural-History Notes." By Rev. T. A. Preston, of Marlborough College. In a letter to Mr. Glaisher.
19. "Some Effects of the Cold of January." By Rev. T. A. Preston, of Marlborough College. In a letter to Mr. Glaisher.
20. "On the Storm which was so severely felt in the more Northern Counties during the Night of the 5th of January." By Arthur Forbes, Esq. In a letter to Mr. Glaisher.
21. "On a Peculiarity in a Cyclone." . By W. R. Birt, Esq. In a letter to Mr. Glaisher.
22. "On the Aurora of 1865, February 17." By A. S. Herschel, Esq. In a letter to Mr. Glaisher.
23. "On the Secular Change of Temperature of the Air at Greenwich." By A. S. Herschel, Esq., B.A.
24. "On Daily Weather Diagram for 1864." By C. O. F. Cator, Esq., M.A.
25. "On Barometers with Scales of Inches and Millimètres." By L. Casella, Esq.
26. "On the Performance of a Watch Aneroid Barometer." By G. J. Symons, Esq., with note by the Editor.
27. "Date of Rainfall, and Close of Rain Month." By G. J. Symons, Esq. In a letter to the Editor.
28. "On the Mortality of London, in connexion with the Daily Weather Diagram for 1864, and the comparisons of the Curves of each of the Elements delineated thereon with each other and with the Mortality." By C. O. F. Cator, Esq., M.A.
29. "On calling Strong Winds Cyclones, which are not Cyclones." By Col. Austen.
30. "On Errors of an Aneroid Barometer." By G. Harvey Simmonds, Esq. In a letter to Mr. Glaisher.
31. "On the Great Storm which occurred at the commencement of October in India." By Henry F. Blanford, Esq., A.R.S.M., F.G.S., Joint Secretary of the Asiatic Society. In a letter to Mr. Glaisher.

82. "Notes on the Aurora Borealis of March 20th, 1865." In communications to Mr. Glaisher.
83. "On the Difference of Winter Temperatures at Greenwich and at Newport." By John C. Bloxam, Esq. In a letter to Mr. Glaisher.
84. "Note on Dry- and Wet-bulb Hygrometer." Communicated by L. P. Casella, Esq.
85. "Note on the Hailstorm of the 24th of March." By Henry F. Blanford, Esq., A.R.S.M., F.G.S.

List of the Donors of the Books presented to the Society during the last year:—

R. Witherby.
Royal Academy of Sciences of Lisbon.
Royal Academy of Sciences of Madrid.
The Swiss Commission.
Scottish Meteorological Society.
H. W. Dövè.
P. Angelo Secchi.
A. Le Verrier.
Balfour Stewart.
Fournet.
W. Adolph.
The Smithsonian Institution.
The Royal Institution.
Scientific Institution of Trinidad.
Royal Swedish Academy.
S. M. Drach.
The French Meteorological Society.
Toronto Observatory.
The Astronomer Royal.
Dr. Mann.
A. Wilcocks.
Admiral Smyth.
Dr. Lee.
G. J. Symons.
The Austrian Government.
Royal Geographical Society.
A. Perry.
Geographical Society of Geneva.
Manuel de Mello.
J. J. Astrand.
E. Edlund.
Royal Observatory of Munich.
C. O. F. Cator.
C. Todd.
Meteorological Society of Mauritius.
C. Meldrum.
Literary and Philosophical Society of Liverpool.
The Oxford Observatory.

The Report having been read, the following Resolutions were carried unanimously:—

Proposed by A. Brewin, Esq.
Seconded by C. Brooke, Esq., M.A., F.R.S.

That the Report, which has just been read, be received and adopted; and that it be printed and circulated among the Members of the Society.

Proposed by A. J. Cuming, Esq., A.K.C.
Seconded by J. P. Harrison, Esq., M.A.

That the cordial and best thanks of the British Meteorological Society be communicated to the Council of the Institution of Civil Engineers for having granted the Society free permission to hold their Meetings in the rooms of the Institution during the Session that has just ended.

The President appointed G. H. Simmonds, Esq., and Thomas Read, Esq., as Scrutineers; a ballot was then taken, and the following list of Members, prepared and proposed by the retiring Council, was received and adopted as Council and Officers for the seventeenth Session, 1865–66:—

THE OFFICERS AND COUNCIL

OF

THE BRITISH METEOROLOGICAL SOCIETY,

ELECTED 21ST OF JUNE, 1865.

President.

C. BROOKE, ESQ., M.A., F.R.S., &c.

Vice-Presidents.

N. BEARDMORE, ESQ., C.E., F.R.A.S., F.R.G.S., F.G.S., &c.
J. LEE, ESQ., LL.D., F.R.S., F.R.A.S., F.G.S., F.L.S., F.S.A.
T. SOPWITH, ESQ., M.A., F.R.S., F.G.S.
S. C. WHITBREAD, ESQ., F.R.S., F.R.A.S.

Treasurer.

HENRY PERIGAL, ESQ., F.R.A.S., 57 *Warren Street, Fitzroy Square*, W.

Secretaries.

J. GLAISHER, ESQ., F.R.S., F.R.A.S., *Dartmouth Place, Blackheath*, S.E.
J. W. TRIPE, ESQ., M.D., 7 *King's Place, Commercial Road*, E.

Foreign Secretary.

LIEUT.-COL. ALEX. STRANGE, F.R.S., F.R.A.S., 41 *Brompton Crescent*, S.W.

Librarian.

A. J. CUMING, ESQ., A.K.C., 25 *Great George Street*, S.W.

Council.

ANTONIO BRADY, ESQ., F.R.G.S., M.M.S.
A. BREWIN, Esq.
Sir C. BRIGHT, M.P., C.E., F.R.A.S.
C. O. F. CATOR, ESQ., M.A.
W. P. DYMOND, ESQ.
H. S. EATON, ESQ., M.A.
J. P. HARRISON, ESQ., M.A.
S. W. SILVER, ESQ., F.R.G.S.
D. SLATE, ESQ.
A. SMITH, ESQ.
G. J. SYMONS, ESQ.
C. V. WALKER, ESQ., F.R.S., F.R.A.S.

The following Resolutions were carried unanimously:—

Proposed by F. W. Doggett, Esq.
Seconded by R. F. Heath, Esq., B.A., L.C.P.

That the thanks of the Society be given to the Officers for their services during the Session that has now closed.

Proposed by C. Brooke, Esq., M.A., F.R.S.
Seconded by H. S. Eaton, Esq., M.A.

That the best thanks of this Society be given to Mr. Walker for the valuable services which he has rendered as one of our Secretaries in editing the 'Proceedings' up to the end of the last Session.

Proposed by G. J. Symons, Esq.
Seconded by Lieut.-Col. Strange, F.R.S., F.R.A.S.

That a special vote of thanks be given to Mr. H. S. Eaton, M.A., in acknowledgment of his valuable services as Librarian to this Society, and of the perseverance with which he raised the Library to its present satisfactory condition.

Proposed by W. P. Dymond, Esq.
Seconded by D. Slate, Esq.

That the thanks of the Society be given to S. C. Whitbread, Esq., Vice-President, for the very courteous manner in which he has conducted the business of the Society devolving on him through the indisposition and decease of our lamented President.

NOTICE.

Session 1865–66.

The Meetings will be held on the Third Wednesday in the months,

at 25 Great George Street, Westminster, S.W.,

by the kind permission of

The Council of the Institution of Civil Engineers.

Ordinary Meetings at 7 p.m.

1865.	November	15	1866.	March	21
1866.	January	17	„	April	18
„	February	21	„	June	20

The Annual General Meeting will be held after the Ordinary Meeting on June 20.

Council Meetings.

1865.	October	18	1866.	March	21
„	November	15	„	April	18
1866.	January	17	„	June	20
„	February	21			

Account of the Treasurer of the British

Receipts.

1864.		£ s. d.	£ s. d.	£ s. d.	£ s. d.
Jan. 1.	To Balance of last year				47 15 4
April.	Dividend on £750 New 3 per Cents			10 18 6	
Oct.	Do. £800 do.			11 14 0	
	Dividends			22 12 6	
Dec. 31.	To Subscriptions:—				
	for 1859	3 0 0			
	Do. for 1860	5 0 0			
	Do. for 1861	17 0 0			
	Do. for 1862	21 0 0			
	Do. for 1863	45 0 0			
	Do. (in arrear)		91 0 0		
	Do. (current year) 1864		208 5 0		
	Do. (in advance) 1865	12 0 0			
	Do. do. 1866	2 0 0			
			14 0 0		
	Subscriptions		313 5 0		
	Seventeen *Life Members* (see names annexed*)		170 0 0	483 5 0	
				505 17 6	
Feb. 25.	Sale of Reports, &c.		10 16 9		
June 27.	Do. do.		7 19 3		
Dec. 31.	Do. do.		3 16 7	22 12 7	
Dec. 31.	Total Receipts				528 10 1
					576 5 5
	Subscriptions to *Charter Fund*				92 11 6
					£668 16 11

1865.		£ s. d.	
Jan. 1.	Balance	73 6 10	£165 18 4
	Charter Fund	92 11 6	

HENRY PERIGAL, Jun., *Treasurer.*

Subscriptions to Charter Fund.

1864.	(*received*)	£92 11 6	
1865.	(*received*)	3 11 0	
	(*in hand*)		£96 2 6
	(*promised*)		80 16 6
	Total		£176 19 0

Meteorological Society for the year 1864.

Expenditure.

1864.		£	s.	d.	£	s.	d.
Feb. 25.	By Printing, &c., Proceedings, No. 9	30	7	9			
May 3.	Do. do. No. 10	33	8	6			
June 27.	Do. do. Nos. 11 & 12	52	2	0			
Oct. 28.	Do. do. Nos. 13 & 14	55	4	6			
Dec. 31.	Do. do. No. 15	15	10	7			
	Printing				186	13	4
June 30.	Registrar-General's Reports	4	0	0			
Dec. 31.	Do. do. do.	3	9	6			
	Tables of Values of Meteorological Elements	0	10	0			
					7	19	6
	Bulletins Quotidiens de Paris				1	10	0
	Binding Books, &c.				3	19	5
Dec. 31.	Stationery	6	14	2			
	Stamped Cheques	0	2	6			
	Postage Stamps	10	18	4			
	Do. do. &c., Secretary Glaisher (3 years)	9	15	6			
Sept. 30.	Do. do. &c., Secretary Walker	4	14	7			
Dec. 31.	Do. do. &c., Librarian	4	7	3			
	Cab-hire, Collector's	2	8	6			
	Attendance, and Refreshments after Meetings	8	16	3			
	Expenses				47	17	1
	Assistant to Secretary Glaisher (one year)	52	0	0			
Sept. 30.	Do. do. Walker (three-quarters)	6	5	0			
Dec. 31.	Commissions on Subscriptions	15	13	0			
	Salaries				73	18	0
	Total PAYMENTS				321	17	4
Feb. 16.	£100 New 3 per Cents, at 90⅞	90	17	6			
19.	£50 do., at 91⅛	45	11	3			
June 16.	Do. do., at 89¼	44	12	6			
	Investments of Compositions				181	1	3
Dec. 31.	Balance—Charter Fund 92 11 6; Do. at Banker's 60 7 3	152	18	9			
	Do. Treasurer's	12	19	7			
	Balance in hand				165	18	4
					£668	16	11

* LIFE MEMBERS.

1864.
Sept. 6. Barnes, W. H., Esq., B.A., F.L.S.
June 29. Betts, E. L., Esq., C.E.
Feb. 15. Bradley, C. L., Esq.
„ 24. Eccles, J. W., Esq.
Apr. 21. Frodsham, Ch., Esq., F.R.A.S.
Jan. 20. Johnson, W., Esq., F.R.A.S.
June 28. Kingsbury, W. J., Esq., M.I.C.E.
„ 21. Lawes, J. B., Esq., F.R.S.

1864.
June 16. Neate, Ch., Esq., C.E.
Feb. 4. Nicholson, Sir Charles, LL.D.
„ 18. Northwick, Rt. Hon. Lord.
June 21. Radford, W. T., Esq., M.D.
Jan. 20. Rock, J., jun., Esq.
„ 27. Stedman, R. S., Esq., M.R.C.S.
„ 20. Swann, Rev. S. K., M.A., F.R.A.S.
„ 20. Symonds, F., Esq., M.R.C.S.
„ 25. Wright, T. B., Esq.

THE CHARTER.

WHILST this Report was passing through the press, the necessary steps were taken, and application has been made to Government. The following is the List of Subscriptions towards the CHARTER FUND :—

Amounts Received.

	£	s.	d.
A. B.	0	10	0
Andrews, W.	1	1	0
Atkinson, G. C.	2	0	0
Austen, Lieut.-Col.	1	0	0
Barrow, H.	2	2	0
Beattie, Alex.	1	0	0
Betts, E. L.	2	0	0
Brady, A.	1	0	0
Brayley, E.	1	0	0
Brooke, W.	0	10	0
C. D.	5	0	0
Coode, J.	1	1	0
Costar, F. W.	3	3	0
Crofton, H. M. E.	5	0	0
Curtis, J.	1	0	0
Dean, H.	1	0	0
Dean, H., jun.	1	0	0
Dines, G.	1	0	0
Dodgson, Dr.	1	1	0
Doncaster, D., jun.	0	10	6
Drach, S. M.	0	10	0
E. F.	0	5	0
Ebury, Right Hon. Lord	5	5	0
	£37	18	6

	£	s.	d.
Carried forward	37	18	6
Eccles, J. W.	1	0	0
Glaisher, J.	5	0	0
Hering, Dr.	1	0	0
Hoskins, Dr. Elliott	1	0	0
Jeans, J. W.	0	10	0
Johnson, H.	10	10	0
Jones, C. Urwick	0	10	6
Kierskowski, C. F.	1	0	0
Lee, Dr.	1	0	0
Livesay, J. G.	1	1	0
Mackereth, T.	0	10	6
McLean, J. R.	10	10	0
Maxwell, Rev. C.	0	10	6
Negretti, H.	1	1	0
Perigal, H.	3	0	0
Pigott, G.	1	0	0
Pollock, T.	1	1	0
Pratt, F.	0	10	6
Preedy, Capt.	0	10	6
Preston, T. A.	1	0	0
Rankin, Dr. W.	1	0	0
Read, T. F.	1	0	0
Smyth, J., jun.	0	10	0
Stewart, B.,	1	0	0
Summerby, W.	0	10	0
Symonds, Frederick	1	1	0
Thurstans, J.	0	10	6
Tudor, E. O.	3	3	0
Vachel, R. C., M.D.	1	1	0
Vernon, G. V.	1	0	0
Ward, Major	1	0	0
Weld, Rev. A.	1	1	0
Whitley, N.	1	1	0
Winstanley, W.	1	0	0
Zambra, J.	1	1	0
	£96	2	6

Amounts Promised.

	£	s.	d.
Arnold, J.	0	10	6
Beardmore, N.	2	2	0
Bloxam, J. C.	2	2	0
Brewin, A.	1	1	0
Brooke, C.	2	2	0
Burder, G. F., M.D.	1	0	0
Burder, W. C.	1	0	0
Cator, C. O. F.	5	5	0
Casella, L. P.	1	1	0
Clarke, Latimer	2	0	0
Coppock, Chas.	0	10	6
Cuming, Alex. J.	1	0	0
Dymond, W. P.	2	2	0
Falls, W. S., M.D.	1	1	0
Galton, F.	3	3	0
Gaster, F.	0	10	6
Ingelow, W. F.	2	2	0
Joyce, A. J.	1	1	0
Lees, I.	0	10	0
Lowe, E. J.	1	1	0
Mylne, R. W.	2	2	0
Silver, S. W.	10	10	0
Slate, D.	5	5	0
Smith, Aug.	5	0	0
Sopwith, T.	5	5	0
Symons, G. J.	2	2	0
Tripe, I. W.	3	3	0
Walker, C. V.	5	5	0
Whitbread, S. C.	10	0	0
Wortham, Hale	1	1	0
	£80	16	6

INDEX OF NAMES OF PERSONS.

INDEX OF SUBJECTS.

A.

B.

C.

D.

E.

F.

G.

H.

J.

K.

L.

M.

T.

V.

W.

THE END OF VOL. II.

Printed by TAYLOR AND FRANCIS, Red Lion Court. Fleet Street.

De Wilde lith ad nat.

M&N. Hanhart imp.